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CONTENTS.

NOTE.—Those who can spare any volumes or parts of this periodical are respectfully requested to inform the Chief of the Weather Bureau.

INDEX.

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BULLETIN

OF THE

MOUNT WEATHER OBSERVATORY

Vol. 5, Part 1. January, February, March, 1912. Closed June 18, 1912.
W. B. No. 489. CLEVELAND ABBE, Editor. Issued October 5, 1912.

(1) DAILY CHANGES IN TEMPERATURE UP TO 4,000 METERS.

By ALFRED J. HENRY.

[Dated March 16, 1912.]

In previous papers in this bulletin the writer has discussed the course of the temperature in the lower layers of the atmosphere as revealed by means of synchronous automatic registers placed at summit and base stations. The last paper of the series appeared in this bulletin, Vol. IV, pages 310–341. It dealt with the temperature variations between Mount Weather and the adjoining valleys, one to the westward and one to the eastward. It was there shown that the amount of the temperature change from one hour to another, or from one day to the next, depended largely upon the character of the weather prevailing at the time, and also differed as between mountain and valley stations in a manner hitherto known, but in which quantitative results showing the effect of cyclonic and anticyclonic control were not available.

In the present paper it is proposed to deal with temperature registrations in the free air obtained at Mount Weather by kites. The writer is fully aware of the objections that will be urged against the use of temperature data which are not homogeneous in the strict sense of that word, but his excuse is that the errors introduced by the irregularity of the hours of observation are small in all of the ascents used by him, and that he has been careful to disregard those records in which there was manifestly danger af an error due to the effect of diurnal variation of the temperature. The diurnal variation in temperature on the surface at Mount Weather is ~~shown by~~ Table 3, this bulletin, Vol. IV, page 327, whence it appears that for the period between 8 a. m. and noon, during which time practically 90 per cent of the kite flights are made, the diurnal variation for any single hour exceeds 2° C. only at 8 a. m., and that for the remaining hours, between 8 a. m. and noon, it is less than 2° C.

In spring, summer, and autumn the average diurnal variation of temperature for the hours of 8, 9, and noon is generally greater than 2° C., so that a comparison of an observation made at 8 a. m. of one day with one made at noon of the next day would introduce a serious error, particularly in clear weather.

In the published data in this paper a correction for diurnal variation has been applied to all surface readings made at different hours whenever differences between the temperature of one day as compared with that of the following day are given. No attempt has been made to correct temperature readings in the free air for diurnal change, for the reason that as yet little is known of the diurnal range of temperature with altitude. It appears that the total amplitude of the diurnal variation at 2 kilometers above sea level over Lindenberg and Berlin is less than 2° C.[1] A series of continuous ascents throughout the 24 hours conducted at this observatory in the summer of 1911 (this bulletin, Vol. IV, pp. 344–346) would seem to indicate a greater amplitude at even 3 kilometers over Mount Weather than above indicated, but the Mount Weather observations were made in summer, when convection is at a maximum. However, the question is far from being definitely settled. For any single flight used in this discussion the change due to the diurnal effect is probably less than the above-named amount; moreover, all flights in which the differences between the recorded temperatures at the same level on consecutive dates were 2° C. or less were disregarded; only those dates were considered in which the change was manifestly not due to the diurnal effect.

In Table 1 are given in degrees centigrade the changes to higher temperature in approximately 24 hours on 26 dates distributed throughout the winter months of 1908–09, 1909–10, and 1910–11. The small number of dates that are available is due to several causes, principally, however, to the fact that flights to approximately the same altitude could not always be made on consecutive days. In the two winters first named flights were not attempted on Sundays, hence a good flight made on either Saturday or Monday was not available for the purpose of this study. It is the exception rather than the rule that the state of the atmosphere at Mount Weather is favorable for high flights on two or more consecutive days, especially in the winter season, and, moreover, the altitude of Mount Weather above the adjoining valleys, although not great, is sufficient to bring the mountain top within the low clouds of cyclones. The density of the clouds and the quantity of water vapor that they bear are usually so great that kite flying in them is almost impossible. The recent advance in the art of aviation has caused the manufacturers of cloth covering for aeroplanes to produce a fabric which does not shrink

[1] E. Gold, Sitzungsberichte, Akad. der Wissen. Wien, October, 1909.

in the rain. The covering of kites with this new cloth promises to increase their efficiency when the mountain top is shrouded in fog.

Table II in like manner contains the record of changes to lower temperatures on 19 days for the altitudes reached on those days. The values in both Tables I and II can be reduced to changes on the Fahrenheit scale by remembering that 1° on the centigrade scale is equivalent to 1.8° on the former.

At Mount Weather falling temperature is generally associated with high winds, often too high to make a kite flight of more than 1,000 meters above the station. This fact stands out clearly in Table II, where the number of ascents to 3,000 meters and over is smaller than in Table I.

The values given in Tables I and II are for those special days on which warming or cooling in the atmosphere was especially noticeable Means have been computed for these special days and are given in the column on the extreme right of the tables. From these means it will be seen that the accidental changes from day to day are greater in falling than in rising temperature. This fact may possibly be explained by considering the process by which changes to lower temperatures in the United States in winter are generally accomplished, viz, by a sudden change in the direction of the wind to northerly or northwesterly, so that great regions are successively invaded by northerly or northwesterly winds whose temperatures stand in marked contrast to those of the winds which had previously prevailed over the same regions; on the other hand, the change to higher temperature is as a rule accomplished slowly and gradually. It is interesting to note that the amplitude of the daily changes expressed in the tables mentioned varies seemingly with altitude. Thus, with rising temperature the average daily change is at a maximum at the 1,000 and 1,500 meter levels rather than at the earth's surface, and a secondary maximum appears to be reached at the 3,500-meter level, although more observations may change the result at that level. Likewise, in falling temperature the maximum daily change is not at the earth's surface but between the 1 and 2 kilometer levels, whence it decreases upward to 4 kilometers. The temperature changes here considered are evidently a real phenomenon and evidently occur in all levels of the atmosphere thus far explored. The temperature registrations on successive days made by sounding balloons in this country and elsewhere show similar decided changes in the free air within 24 hours.

The sounding balloon registrations made at Omaha, Nebr., September 27 and 28, 1909 (this bulletin, Vol. IV, pp. 213, 214, 276), show an increase of temperature in 24 hours at the 12-kilometer level (7.5 miles) of 14° C. (25.2° F.). This decided increase in temperature was accompanied by a fall in the surface barometric pressure and a

change in the direction of the wind throughout a stratum of the air probably 9 miles in depth.

Similar changes in temperature at great heights in the atmosphere have been recorded in the sounding balloon ascensions made on international days. Comment on certain large daily changes recorded over Europe on December 5, 6, and 7, 1906, was made by Albert Peppler in "Beitrage zur Physik der Freien Atmosphäre" IV Band, Heft 2–3, Seite 116. Peppler has constructed from the international ascents for the above-named dates a temperature change chart for the 7-kilometer (4.3-mile) level over middle and western Europe. The magnitude of the changes at the above level is of the same order as that observed at the earth's surface.

Changes in the temperature of the free air over any point may be brought about in several ways, viz, by solar radiation, radiation from the earth and the air itself conduction from the earth's surface, by convection currents and also by compression in descending currents as when air is brought under greater pressure, but the greatest single cause is believed to be the horizontal transport of air from regions of higher or lower temperature, respectively, and this cause seems to be the one chiefly concerned in producing the changes that we have presented in this article. Solar radiation is, of course, indirectly at the basis of all temperature changes in the atmosphere, but the visible manifestations of such are presented to us mainly by the winds, and the latter are so closely associated with moving cyclones and anticyclones that we have come to look upon these latter moving air masses as the chief control of the weather. Solar radiation is effective in warming the layers of the air in contact with the earth's surface mainly through conduction and convection. The effect of conduction is known to be confined to the air within a few meters of the earth's surface. The precise quantitative effects of convection and the height in the atmosphere at which the process is effective are not definitely known. According to Abbot and Fowle,[1] 37 per cent of the solar radiation is reflected by the earth as a planet and takes no part in warming it; of the 63 per cent which passes to the earth, a little more than two-thirds is absorbed at the earth's solid and liquid crust or in the atmosphere within a mile of sea level. This would leave but one-third of 63 per cent, 21 per cent of the total available solar radiation to be absorbed by the atmosphere, but since the absorbing power of the atmosphere is believed to be less than its radiating power, it is difficult to ascribe the warming herein referred to either wholly or in great part to solar radiation. Warming by compression is also rejected as a probable cause of the warming observed, first because of the absence of evidence of descending air of sufficient magnitude to cause the observed changes and second because

[1] Annals of the Astrophysical Observatory, Vol. II.

the presence of clouds on the days on which the warming was observed indicates that the moisture content of the air on those days was greater than it should have been were the air actually descending and thereby gaining heat.

The obliquity of the sun's rays in summer is less than in winter, and therefore the amount of heat communicated to the atmosphere must be greater. If therefore the changes of temperature we are considering are due to solar radiation they should be greatest in summer. But, as will appear later in this paper, the changes in summer are less than in winter.

The one serious objection to the argument that the heating and the cooling in the free air is due to the importation of warmer or cooler air, respectively, lies in the fact that winds from a southerly quarter are not uniformly warm winds, and likewise winds from a northerly quarter are not always relatively cold winds.

On this point, however, it may be said that we are not in possession of any definite information as to the origin of the air which passes over Mount Weather as a north or west wind. Shaw and Lempfert [1] have pointed out that the slower the motion of the center the more does the path which suggests itself on the synoptic chart approach that of the actual path of the air. It is conceivable and quite probable that in some cases the air of a west or even northwest wind has, say within the previous 24 hours, been drawn from the south, as when a slow-moving anticyclone is central in the Ohio Valley, just west of Mount Weather. Figure 5 is a reproduction from this Bulletin, Vol. IV, page 337, of the Washington Daily Weather Map of February 7, 1910, a day on which the warming in the free air above Mount Weather was quite pronounced, as was also the warming between the time of ascent and descent of the kites. The divergence of the temperature diagram toward the left in the descent indicates the amount of rise in temperature between the time of ascent and descent. For the numerical values of the warming on the date in question, see Table VII this bulletin, Vol. IV, p. 330.

In order to reach quantitative result as to the prevailing temperature of southerly winds in winter, I have selected from the daily kite flights at Mount Weather made during January, 1908, 1909, 1910, and 1911, 25 flights in which southerly winds prevailed, counting from say 1,000 meters above sea level to the top of the flight obtained on the date in question. The temperatures on those days at the various levels in the free air in 250-meter steps have been tabulated and the means computed. Comparing the means thus computed for southerly winds with the means at corresponding levels for winds from all directions as published in this bulletin, Vol. III, page 32, Table I, it is seen that southerly winds are warmer on the

[1] Life History of Surface Air Currents: M. O. No. 174, 1906.

average than the winds from all quarters combined for the respective levels and by the amounts set opposite said levels in the small table below:

Departures of the temperatures of southerly winds from the general mean.

[The departures are all positive and in degrees C.]

Above sea level.	Jan.	Feb.	Above sea level.	Jan.	Feb.
Meters.	°C.	°C.	*Meters.*	°C.	°C.
526	1.1	0.4	2,500	3.7	4.7
750	2.1	1.4	2,750	3.0	4.6
1,000	3.1	3.1	3,000	2.3	4.3
1,250	3.5	3.9	3,250	3.0	4.2
1,500	4.1	4.1	3,500	3.3	3.8
1,750	4.2	4.4	3,750	3.9	3.0
2,000	3.9	4.5	4,000	3.7	3.6
2,250	3.6	4.1			

In the term "southerly" winds we have included winds from the south, south-southwest, southwest and west-southwest, but not southeast except at the surface. It is readily seen from the above that on the average southerly winds are relatively warm winds up to 4,000 meters—or as far as the flights extend. There appears to be a maximum zone for warming in January at about 1,750 meters above sealevel (5,741 feet). The February maximum is found somewhat higher, viz, at 2,500 meters above sea level (8,202 feet). The actual mean temperature of southerly winds above Mount Weather for January and February are graphically shown in figure 1, whence it is clearly seen that there is a marked inversion between the surface temperatures and those at an altitude of about 1,500 meters in January and about 1,750 meters in February. This is characteristic of the winter season. At this point the changes of temperature in the free air in summer were taken out in the same manner and with the same care as hereinbefore described for winter. In spite of the fact that the records of 12 summer months were used less than a dozen flights were found to be available for this discussion. This scarcity of comparable flights for the summer may be referred to several causes, chief of which are:

(1) The less turbulent state of the atmosphere in summer than in winter and the consequent absence of kite-flying winds save only in the transition regions between retreating cyclones and advancing anticyclones and in such regions the temperature rarely increases from one day to the next.

(2) The frequent use of captive balloons in summer whose records of temperature especially in the levels near the top of the ascension, are faulty through insufficient ventilation.

The aerial section of this observatory has recognized for some time that the lack of ventilation in captive balloon ascents seriously impaired the accuracy of the temperature records obtained from such

ascensions. Efforts have been and are being made to increase the ventilation. Captive balloon ascensions are generally made in the afternoon and the results therefore, so far as temperature is concerned, are not strictly comparable with the results of kite flights, which as a rule are made in the early morning hours. For the reasons herein stated the number of days on which a comparison between the temperature of one day and that of the succeeding day in cases cf rising temperature could be properly made is extremely small. On the other hand, in cases of falling temperature, which at Mount Weather are generally associated with fresh winds, nearly twice as many flights are available although the total number is yet too small. The special days on which the temperature in the free air above Mount Weather rose or fell by an amount greater than 3° C. (5.4° F.) and the amount of the change are given at the end of this paper in Tables III and IV.

As in winter the accidental changes in temperature from one day to the next are greater in cases of falling than in rising temperature, and for probably the same reason. The magnitude of the changes is naturally less in summer than in winter, and the peculiarities hereinbefore remarked as to the magnitude of the daily change varying with the altitude appears to hold for summer as well as winter. Thus in rising temperature the amplitude of the daily accidental changes is greatest not on the surface, as one would expect, but at the 1 000-meter level, or 1,348 feet above the surface of the mountain. Similarly in cases of falling temperature the amplitude of the daily accidental changes is greatest from 1,000 to 1,500 meters above sea level, or 1,348 to 3,195 feet above the mountain top.

The individual values of change in temperature to be found in Tables I to IV and many others studied in connection with the subject do not show that there is any progressive warming or cooling from above downward, or vice versa. Generally both warming and cooling may be in progress for more than a single day. As stated in a previous paper, warm horizontal currents are generally felt on the mountain top before they descend to the lower valleys. The cold-air streams, however, so far as the available observations indicate, occur almost simultaneously aloft and at the earth's surface. Above 4,000 meters it seems probable that the warmth of the cyclone prevails longer than in lower levels. In Tables I to IV there will be observed some incongruous relations. Thus on January 26, 1910, there was no change in the temperature at the surface of the earth, but there was a well-marked increase of temperature at the 1,000-meter level and thence upward to 4 kilometers. The most of such cases can be explained by reference to the daily Weather Map. The absence of warming at the earth's surface on that date was due to the fact that Mount Weather had not yet come under the influence of the approaching cyclone. The surface winds on the mountain were from

the southeast. One would think that owing to the proximity of Mount Weather to the Atlantic Ocean on the east and southeast the distance being approximately 160 miles 257 kilometers that winds from that quarter in winter would be warm winds. They are in fact cold winds and shallow evidently of continental rather than oceanic origin. One of the definitive results which can be drawn from the kite flights at Mount Weather is the very great inequality between the east to south winds in the front of a cyclone and the west to northwest winds in its rear. Easterly winds are shallow and generally of low speed while westerly winds are much deeper and of greatly higher velocity, probably in the ratio of 3 to 1. Before leaving the discussion of the data in Tables I to IV it should be remarked that naturally the amount of change in temperature from one day to the next in the free air, as well as in the air on the earth's surface depends very largely upon the state of the weather; that is whether under cyclonic or anticyclonic control. In settled weather when neither the cyclonic nor the anticyclonic influence predominates the changes will be small and unimportant; in anticyclonic weather the temperature, over Mount Weather at least, increases from day to day and the more stagnant is the atmosphere, the greater will be the increase; in the transition region between a passing anticyclone and an approaching cyclone the changes will be toward higher temperature and they may be of considerable magnitude. The greatest absolute change of temperature in a short space of time will be found in the rear of a cyclone after the winds have changed from southerly to northerly. The precise amount of that change we can at present only approximate, since just before and after the passage of a barometric minimum the atmospheric conditions are generally prohibitive of kite flying.

On December 27 1911 the aerial section of this observatory succeeded in getting a kite flight of about 2 500 meters above sea level while the station was in the southeastern quadrant of a great barometric minimum with lowest pressure 29.15 inches (740.16 mm.) over Georgian Bay. When the flight was started the wind at the surface of Mount Weather had changed from southwest to west-northwest, but it remained from the southwest in all other levels reached by the kites. A second flight was undertaken about two hours after the first flight was completed; meanwhile the wind had changed direction in the air layers next to the earth and the temperature was falling. A plot of the temperature at the different levels in the two flights is shown in figure 2. It will be readily seen therefrom that with the change in the wind direction a marked fall in the temperature, amounting on the surface to 8° C. (14.4° F.) from the beginning of the first flight until the end of the second flight took place. At the level of 1,500 above sea the fall was from 7.4° C. at 9.21 a. m. to −5.0° C. at 2.5 p. m. or 12.4° C. (22.3° F.) in 4 hours and 44 minutes. On the day following (Dec. 28, 1911) the 1 500-meter

level was reached at 11.30 a. m. and the temperature was found to be $-16.2°$ C. (2.8° F.) therefore we have three measurements of the temperature at 1 500 meters above sea level whence we may calculate the hourly rate of fall under extreme weather conditions: The first set of measurements those immediately subsequent to the shift in the wind direction give an hourly rate of fall of 2.6° C. The descent in the second flight—see the broken line—was accomplished in 50 minutes. The amount of cooling between the time of ascent and descent in the second flight (the lower half of it) was about 3.5° C. in one and a half hours an amount which corresponds fairly well with that above found for the elapsed time between the two flights; the second set of measurements viz from the 27th to the 28th gives an hourly rate of fall of 0.9° C. in 26 hours or almost 1° C. per hour and this rate is believed to closely approximate the 24-hour rate under similar extreme conditions.

In this bulletin, Vol. IV, page 330, some statistics of hourly rate of temperature change, based on differences observed between the time of ascent and descent of the kites, are given. It seems likely that the hourly rate of change is partly dependent on the actual temperatures at the time of comparison, being greater for very low or very high temperatures than for average temperatures.

We now pass to a consideration of the weather conditions under which changes in temperature in the free air are most likely to occur. To show the relative position of cyclones and anticyclones on days when warming or cooling was most pronounced above Mount Weather, I have prepared two charts, one each for rising and for falling temperature in the winter season, respectively. Figures 3 and 4. The entries on said charts are explained as follows: The entries preceded by the letter H (high) show the position and dates of anticyclones; the corresponding cyclones are shown by similar date entries preceded by the letter L (low). Thus, on figure 3, rising temperature, there will be found off the New Jersey coast the entry H–1–31–08. This indicates that on January 31, 1908, an anticyclone was central in that position. The position of the corresponding cyclone of January 31, 1908, is indicated under a similar date entry preceded by the letter L, and examining the chart that entry L–1–31–08 will be found over Oklahoma. The rise in temperature over Mount Weather on that date will be found in Table I, under the column for 1–31–08.

Figure No. 4 has been prepared in a similar manner to cover all the cases of falling temperature at Mount Weather. They are given in Table II.

The most obvious feature of these two charts is that for rising temperature in the free air above Mount Weather the center of the anticyclone (H) is east of Mount Weather and the cyclone (L) is to the westward; in the case of falling temperature the center of the anticyclone (H) is to the westward of Mount Weather and the center

of the cyclone (L) is either to the eastward or northward. The distance of the cyclone from Mount Weather and its latitude do not, at least in the case of rising temperature, seem to be important factors in the case. The pressure distribution on January 31, 1908, anticyclone (H), over eastern Pennsylvania and New Jersey (cyclone (L), over Oklahoma) is typical of a condition that has been explored a number of times and is one of which we can speak with some confidence. Its chief characteristics are a south to west wind aloft and generally a marked temperature inversion.

No general rule as regards the fall of temperature to be expected in the rear of a cyclone can be drawn from the observations in the free air over Mount Weather, and this is partly due, first, to the scarcity of flights in cyclones, and, second, to important differences in individual cyclones. These differ (1) in the initial temperatures which they possess, hence a statement of the temperature found at a certain level of a cyclone has little significance when considered alone; (2) the rate of movement and the relative distance of the attendant anticyclone—that is, whether close at hand or far removed from the cyclone—are important points to be considered in determining the probable temperature fall. On January 5–6, 1909, a cyclone passed to the eastward of the meridian of Mount Weather, while the attendant anticyclone was yet in the Mississippi Valley. The temperature in a layer of air extending from the mountain top up to 1,250 meters above sea level fell, as was to have been expected, but from the above level up to and including 2,250 meters the temperature rose. The rise in temperature aloft would seem to indicate that the center of the cyclone at the level of about a mile above the earth was far in the rear of the center at the earth's surface. Many years ago Loomis pointed out that at the summit of Mount Washington the center of the cyclone lagged behind the center at the earth's surface by several hundred miles. Another very interesting case illustrating the fall of temperature in the higher levels of a cyclone is that of February 26, 1908 (see Table II). On that day the flight was made directly in the rear of a well-marked barometric depression that was centered over Maryland to the east of Mount Weather. The temperature at the earth's surface and up to 1,000 meters above sea level still possessed the warmth of the cyclone; above 1,000 meters, however, it had fallen as compared with the temperature of the corresponding levels on the previous day, the amounts ranging from 2.8° C. at 1,500 meters to 10.4° C. at 4,000 meters.

The last named amount evidently represents the extreme change at that altitude from the warmth of the cyclone to the cold which follows it. It should be remarked, however, that the winds on the 26th at 4,000 meters were from the southwest, as they had been on the previous day. On another occasion, January 23, 1908, the lowest temperature for the month at 4,000 meters was recorded with a southwest wind

in a cyclone whose center was over Lake Erie. We have, therefore, the curious anomaly of the southwest wind being unduly warm in the lower levels of a cyclone and of showing marked cooling in the higher levels up to 4 kilometers. The cooling in the higher levels is confined to the rear of the cyclone and seems to occur after precipitation. Instead of the condensation of aqueous vapor in the atmosphere producing a slight warming as required by theoretical considerations all the evidence on the subject seems to point to cooling instead of warming. Since the cooling in both the above-mentioned cases occurred without a change of the wind to a northerly or westerly quarter, we are obliged to look elsewhere for the cause of the cooling. In the present state of our knowledge on the subject anything we might offer would be largely surmise.

A very interesting and instructive article by Dr. H. v. Ficker on the progressive movement of warm waves in Russia and north Asia has just appeared in the Sitzungsberichte of the Vienna Academy, Band CXX, heft VI, abteilung IIa, June, 1911. Dr. von Ficker refers the warm waves which appear in Russia and north Asia to southwest winds which proceed from warm regions in the southwest and west. He also points out that the rear of a cold wave and the front of a warm wave are identical, and the warm southwest wind in the rear of a warm wave is underrun and thus crowded up to greater elevations by advancing cold waves—phenomena which are also clearly perceived in this country.

TABLE I.—*Daily changes in temperature (winter), in degrees C., in free air above Mount Weather, Va. (Rising temperature.)*

Flight began:									
Year	1908	1908	1908	1909	1909	1909	1910	1910	1910
Date	Dec. 4	Dec. 15	Dec. 18	Dec. 4	Dec. 11	Dec. 17	Dec. 10	Dec. 14	Dec. 28
Hour	[1] 7h 17m	[1] 7h 18m	[1] 9h 48m	[1] 8h 36m	[1] 8h 33m	[1] 7h 38m	[1] 8h 35m	[1] 8h 51m	[1] 8h 16m
On preceding date	[1] 9h 37m	[1] 7h 41m	[1] 8h 47m	[1] 8h 18m	[1] 10h 13m	[1] 8h 20m	[1] 8h 40m	[1] 8h 36m	[1] 7h 32m
24-hour change at—									
Surface	5.0	8.3	11.7	8.6	3.1	2.2	1.1	6.1	0.5
1,000 meters	9.2	8.4	14.4	1.6	9.1	6.0	6.4	7.8	8.6
1,500 meters	6.1	6.3	8.2	6.5	7.9	5.0	5.1	5.7	7.3
2,000 meters	3.2	4.1	1.9	7.4	5.5	4.3	2.7	8.8	3.1
2,500 meters	....	....	....	6.1	8.1	5.8	1.7	9.2	2.3
3,000 meters	....	....	....	5.0	5.0	4.9	2.1	9.0	....
3,500 meters	....	....	....	3.7	....	6.5	2.8	8.0	....
4,000 meters	....	....	....	2.7	....	6.1	2.8	....	....

Flight began:									
Year	1908	1908	1909	1910	1910	1911	1911	1909	1909
Date	Jan. 4	Jan. 31	Jan. 2	Jan. 20	Jan. 26	Jan. 6	Jan. 8	Feb. 4	Feb. 10
Hour	[1] 7h 48m	[1] 7h 30m	[1] 8h 52m	[1] 9h 15m	[1] 8h 58m	[1] 8h 21m	[1] 8h 12m	[1] 11h 59m	[1] 9h 20m
On preceding date	[1] 7h 54m	[1] 9h 58m	[1] 7h 25m	[1] 8h 38m	[1] 10h 29m	[1] 8h 34m	[1] 7h 55m	[1] 7h 26m	[1] 7h 28m
24-hour change at—									
Surface	−0.6	−0.6	2.8	7.2	0.0	6.1	−0.6	9.0	8.8
1,000 meters	3.9	2.9	5.0	13.2	13.1	11.6	4.0	6.8	6.9
1,500 meters	4.9	4.3	0.8	13.0	9.4	11.2	3.5	9.6	7.5
2,000 meters	2.6	8.4	0.5	11.8	6.8	9.4	3.9	....	8.5
2,500 meters	0.9	5.8	0.7	....	6.5	....	4 2	....	7.9
3,000 meters	0.7	6.3	3.5	....	7.1	....	2.9	....	....
3,500 meters	....	5.2	....	....	7.9	....	2.7	....	....
4,000 meters	....	....	....	....	6.2	....	1.7	....	....

1=a. m.

Table I.—*Daily changes in temperature (winter), in degrees C., in free air above Mount Weather, Va. (Rising temperature)*—Continued.

Flight began:									Number of observations.	Mean.
Year	1909	1909	1910	1910	1910	1910	1911	1911		
Date	Feb. 12	Feb. 18	Feb. 2	Feb. 8	Feb. 15	Feb. 21	Feb. 11	Feb. 25		
Hour	[1] 7h 26m	[1] 7h 08m	[2] 4h 31m	[1] 8h 38m	[1] 8h 37m	[1] 11h 40m	[1] 8h 07m	[1] 8h 01m		
On preceding date	[1] 7h 11m	[1] 1h 23m	[2] 2h 05m	[1] 8h 49m	[1] 8h 48m	[1] 9h 06m	[1] 8h 31m	[1] 8h 23m		
24-hour change at—										
Surface	3.4	5.6	7.2	17.2	10.6	15.5	−0.6	6.1	26	5.5
1,000 meters	9.7	5.1	11.9	15.2	10.4	7.2	4.4	7.5	26	8.1
1,500 meters	14.5	5.2	5.2	7.1	9.5	1.9	11.4	10.3	26	7.2
2,000 meters	....	4.2	2.7	3.1	10.2	2.9	11.3	12.3	24	5.8
2,500 meters	....	4.8	1.6	0.3	10.8	0.7	11.8	11.5	18	4.9
3,000 meters	....	7.3	2.3	0.2	13.3	2.7	....	....	15	4.8
3,500 meters	....	9.7	2.5	....	11.7	....	....	....	11	6.1
4,000 meters	....	11.0	....	....	....	....	....	....	6	5.1
4,500 meters	....	11.6	....	....	....	....	....	....	....	....

1=a. m.; 2=p. m.

Table II.—*Daily changes in temperature (winter), in degrees C., in free air above Mount Weather, Va. (Falling temperature.)*

Flight began:								
Year	1908	1908	1909	1910	1910	1909	1909	1909
Date	Dec. 19	Dec. 25	Dec. 16	Dec. 16	Dec. 30	Jan. 16	Jan. 26	Jan. 7
Hour	[1] 7h 46m	[1] 8h 50m	[1] 8h 20m	[1] 8h 20m	[2] 3h 57m	[1] 7h 00m	[1] 7h 50m	[1] 7h 42m
On preceding date	[1] 9h 48m	[1] 7h 24m	[1] 7h 39m	[1] 8h 24m	[1] 11h 26m	[1] 7h 30m	[1] 7h 17m	[1] 8h 56m
24-hour change at—								
Surface	2.8	10.6	5.5	13.9	14.4	13.9	6.7	18.9
1,000 meters	10.6	2.1	5.5	16.6	17.6	14.7	12.3	19.5
1,500 meters	15.9	4.6	5.0	18.3	16.1	13.3	13.1	21.2
2,000 meters	15.2	5.5	3.4	....	9.9	6.7	15.3	....
2,500 meters	9.7	5.5	7.2	....	....	5.7	....	....
3,000 meters	7.8	7.0	8.9	....	....	....	....	....
3,500 meters	....	....	9.7	....	....	....	....	....

Flight began:								
Year	1910	1911	1908	1908	1909	1909	1909	1910
Date	Jan. 7	Jan. 16	Feb. [illegible]2	Feb. 26	Feb. 11	Feb. 17	Feb. 25	Feb. 6
Hour	[2] 1h 44m	[1] 9h 57m	[1] 7h 36m	[2] 1h 20m	[1] 7h 11m	[2] 1h 23m	[2] 2h 59m	[1] 9h 41m
On preceding date	[2] 1h 31m	[1] 10h 00m	[1] 7h 36m	[1] 7h 59m	[1] 9h 20m	[1] 11h 01m	[2] 1h 01m	[1] 8h 39m
24-hour change at—								
Surface	5.0	17.1	0.6	+7.8	13.3	18.3	16.1	8.9
1,000 meters	22.0	20.3	9.8	+6.3	16.4	13.0	17.2	10.3
1,500 meters	17.0	18.5	13.1	2.8	19.2	10.7	18.0	12.1
2,000 meters	....	12.9	14.4	5.8	....	9.3	....	15.7
2,500 meters	....	....	11.8	8.2	....	....	....	....
3,000 meters	....	....	10.6	7.5	....	....	....	....
3,500 meters	....	....	8.9	8.8	....	....	....	....
4,000 meters	....	....	....	10.4	....	....	....	....

Flight began:							Number of observations.	Mean.
Year	1910	1911	1911	1911	1908	1911		
Date	Feb. 10	Feb. 5	Feb. 19	Feb. 28	Jan. 23	Feb. 14		
Hour	[1] 9h 19m	[1] 8h 21m	[1] 8h 15m	[1] 8h 17m	[1] 7h 00m	[1] 8h 10m		
On preceding date	[1] 8h 28m	[1] 10h 00m	[1] 8h 34m	[1] 8h 10m	[1] 7h 30m	[1] 8h 24m		
24-hour change at—								
Surface	5.5	5.0	10.6	11.7	10.6	2.3	22	9.3
1,000 meters	11.9	10.8	9.7	9.9	9.0	+1.5	22	11.4
1,500 meters	16.5	8.5	9.2	7.3	8.5	0.4	22	12.3
2,000 meters	13.0	4.0	10.9	8.8	[a] 11.2	1.7	17	9.0
2,500 meters	10.5	1.9	....	....	[a] 9.9	3.1	10	7.3
3,000 meters	....	1.9	....	....	[a] 11.0	5.1	8	7.5
3,500 meters	....	1.2	....	....	[a] 12.0	....	5	8.1
4,000 meters	....	3.4	....	....	[a] 10.0	....	3	7.9

1=a. m.; 2=p. m.

[a] This is a 48-hour change.

Note.—Absence of sign indicates a fall in temperature from the preceding day; plus (+) signs indicate a rise.

TABLE III.—*Daily changes in temperature, summer (in degrees C.), in the free air above Mount Weather. (Rising temperature.)*

Flight began:								
Year	1909	1910	1910	1910	1911	1908	Number of observations.	Mean.
Date	June 16	June 2	June 18	June 29	June 7	July 17		
Hour	$^{1}7^{h}32^{m}$	$^{1}8^{h}00^{m}$	$^{1}8^{h}31^{m}$	$^{1}8^{h}18^{m}$	$^{1}9^{h}57^{m}$	$^{1}7^{h}09^{m}$		
On preceding date	$^{1}8^{h}33^{m}$	$^{1}7^{h}04^{m}$	$^{1}8^{h}49^{m}$	$^{1}8^{h}21^{m}$	$^{1}6^{h}43^{m}$	$^{1}7^{h}13^{m}$		
24-hour change at—								
Surface	0.2	7.6	1.1	3.8	−0.4	4.9	6	2.9
1,000 meters	0.9	8.4	3.0	4.5	2.1	4.8	6	3.9
1,500 meters	0.5	4.8	4.3	3.8	1.9	1.5	6	2.8
2,000 meters	2.5	3.7	3.7	....	2.7	−0.4	5	2.4
2,500 meters	5.0	4.0	2.9	....	4.8	3.3	5	4.0
3,000 meters	....	1.4	2.0	....	5.8	4.6	4	3.4
3,500 meters	....	....	1.1	....	6.4	3.8	3	3.8
4,000 meters	....	....	....	....	....	0.4	1	....

1=a. m.; 2=p. m.

TABLE IV.—*Daily changes in temperature, summer (in degrees C.), in the free air above Mount Weather. (Falling temperature.)*

Flight began:										
Year	1908	1908	1909	1909	1910	1911	1911	1908	1909	1909
Date	June 25	June 26	June 16	June 18	June 7	June 12	June 29	July 15	July 17	July 19
Hour	$^{1}7^{h}31^{m}$	$^{1}7^{h}06^{m}$	$^{1}8^{h}33^{m}$	$^{1}8\ 40^{m}$	$^{1}6^{h}55^{m}$	$^{1}7^{h}54^{m}$	$^{1}6^{h}37^{m}$	$^{1}6^{h}59^{m}$	$^{1}6^{h}47^{m}$	$^{1}7^{h}28^{m}$
On preceding date	$^{1}6^{h}21^{m}$	$^{1}7^{h}13^{m}$	$^{1}7^{h}10^{m}$	$^{1}9^{h}19^{m}$	$^{1}8^{h}38^{m}$	$^{1}6^{h}59^{m}$	$^{1}8^{h}58^{m}$	$^{1}7^{h}11^{m}$	$^{1}9^{h}54^{m}$	$^{1}7^{h}08^{m}$
24-hour change at—										
Surface	2.0	4.0	4.0	1.3	4.6	0.8	6.7	7.5	2.7	8.4
1,000 meters	8.3	3.7	4.4	8.8	4.5	8.7	5.0	4.3	5.1	7.2
1,500 meters	8.3	3.1	3.2	9.2	4.4	6.1	+0.4	4.6	4.7	6.1
2,000 meters	....	2.8	3.0	8.1	2.8	4.2	+2.5	4.6	4.3	5.5
2,500 meters	....	....	3.0	5.5	2.6	3.8	+1.5	0.1	2.3	....
3,000 meters	....	....	3.5	4.0	2.3	3.0	+0.2	....	....	....
3,500 meters	....	....	2.8	....	3.4	3.2	....	....	....	....

Flight began:										
Year	1910	1910	1911	1909	1909	1910	1910	1911	Number of observations.	Mean.
Date	July 18	July 31	July 25	Aug. 17	Aug. 21	Aug. 5	Aug. 26	Aug. 19		
Hour	$^{1}7^{h}27^{m}$	$^{1}6^{h}28^{m}$	$^{1}6^{h}42^{m}$	$^{1}7^{h}35^{m}$	$^{1}6^{h}53^{m}$	$^{1}6^{h}36^{m}$	$^{1}8^{h}49^{m}$	$^{1}6^{h}40^{m}$		
On preceding date	$^{1}6^{h}33^{m}$	$^{1}8^{h}34^{m}$	$^{1}6^{h}22^{m}$	$^{1}8^{h}46^{m}$	$^{1}8^{h}03^{m}$	$^{1}7^{h}17^{m}$	$^{1}11^{h}12^{m}$	$^{1}6^{h}45^{m}$		
24-hour change at—										
Surface	4.4	6.4	10.0	5.6	4.4	1.8	5.3	5.3	18	5.2
1,000 meters	6.6	6.0	10.8	4.6	8.5	2.8	2.4	8.2	18	6.1
1,500 meters	10.2	4.8	11.7	6.8	8.4	4.8	1.3	9.6	18	5.9
2,000 meters	7.3	3.6	11.4	8.4	....	4.6	1.3	9.1	16	4.9
2,500 meters	....	0.3	6.1	....	....	2.9	2.1	5.2	12	2.7
3,000 meters	....	0.7	4.6	....	....	0.0	1.9	1.7	10	2.1
3,500 meters	....	2.9	3.8	....	....	+0.8	1.6	....	7	2.4
4,000 meters	....	1.6	2.7	....	....	0.0	....	....	....	1.4

1=a. m.; 2=p. m.

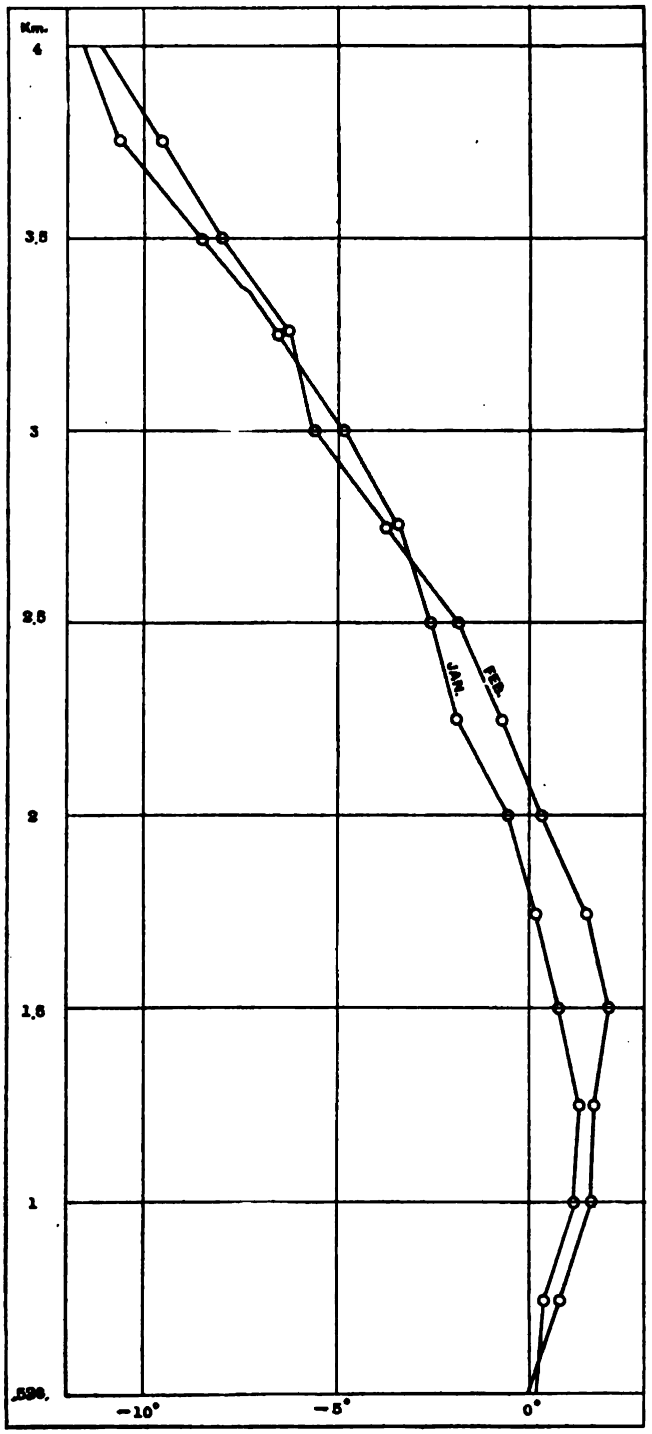

FIG. 1.—Average actual temperatures above Mount Weather during southerly winds: 25 ascents in January and 25 in February.

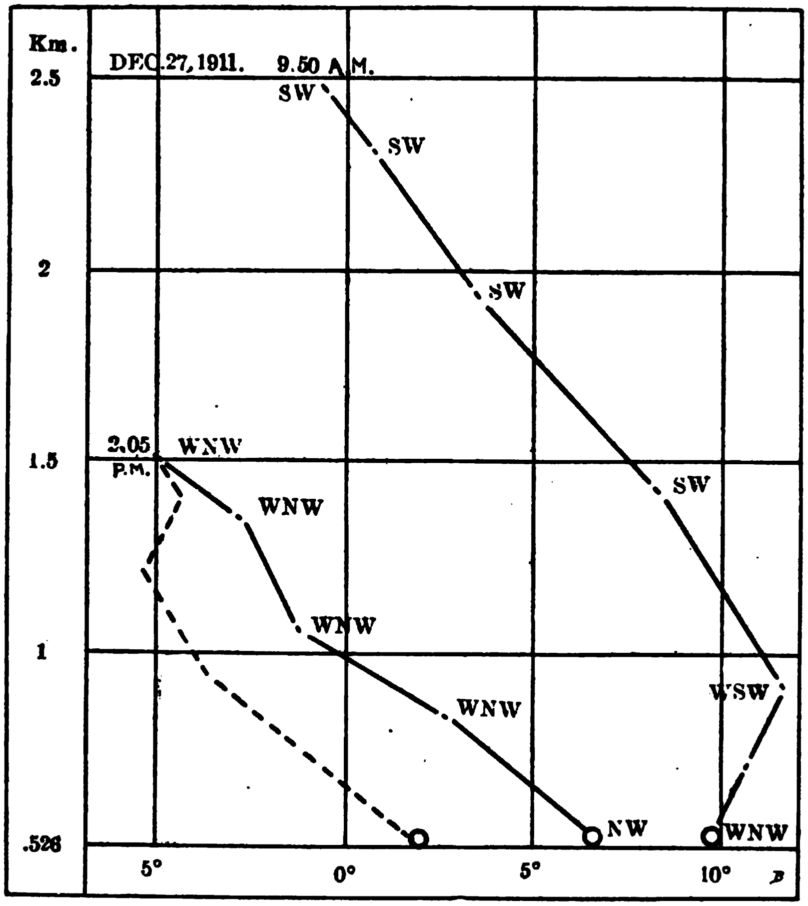

FIG. 2.—Temperatures above Mount Weather during two successive kite flights: 17th December, 1911.

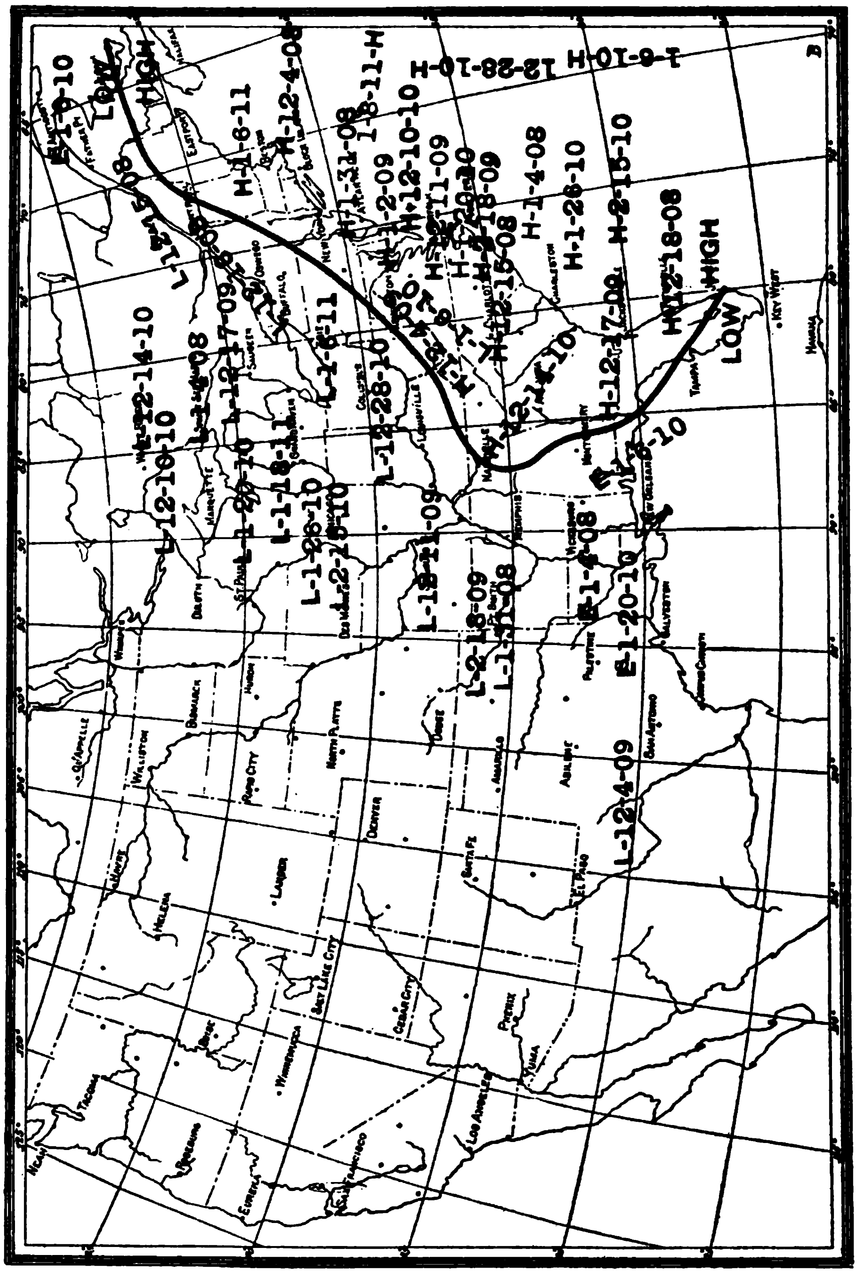

FIG. 3.—The relative positions of high and low pressures during rising temperature at Mount Weather.

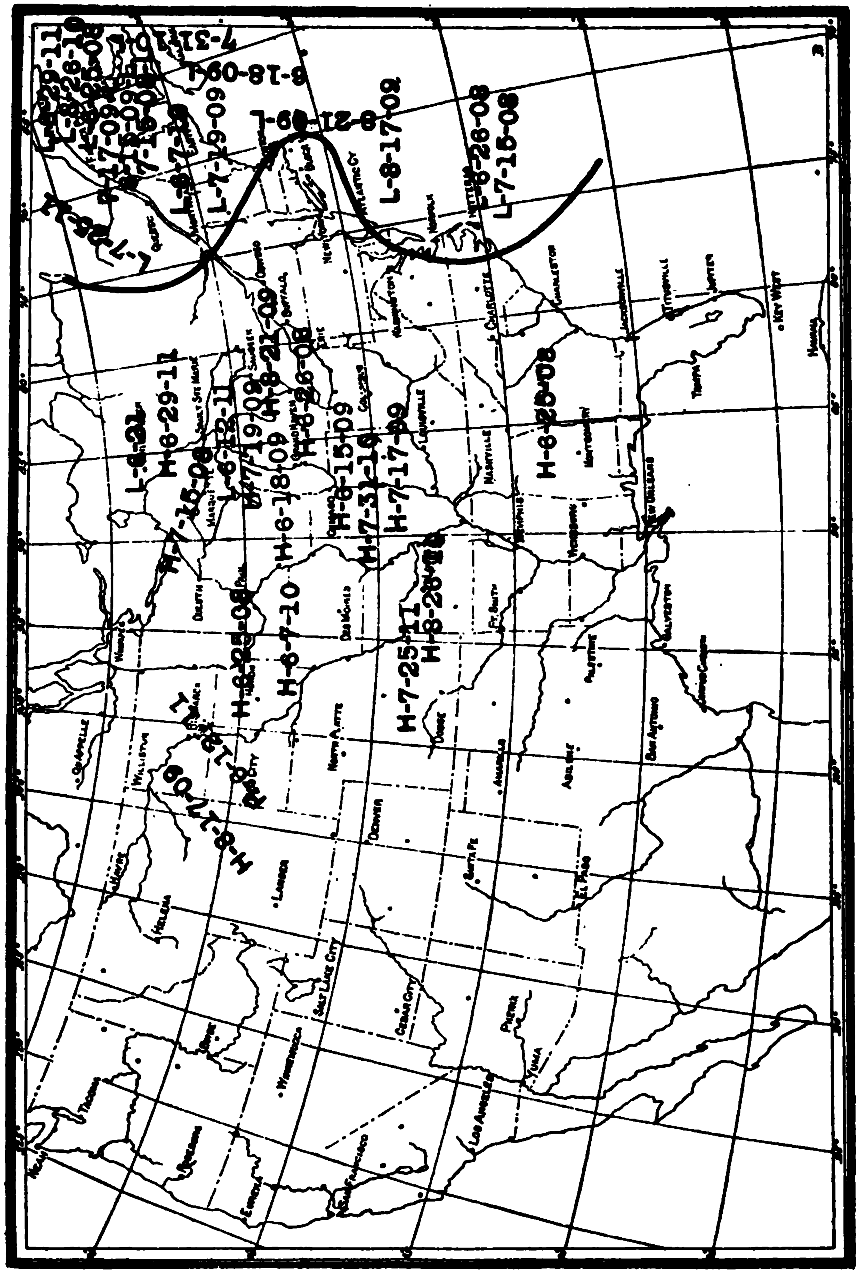

FIG. 4.—The relative positions of high and low pressures during falling temperature at Mount Weather.

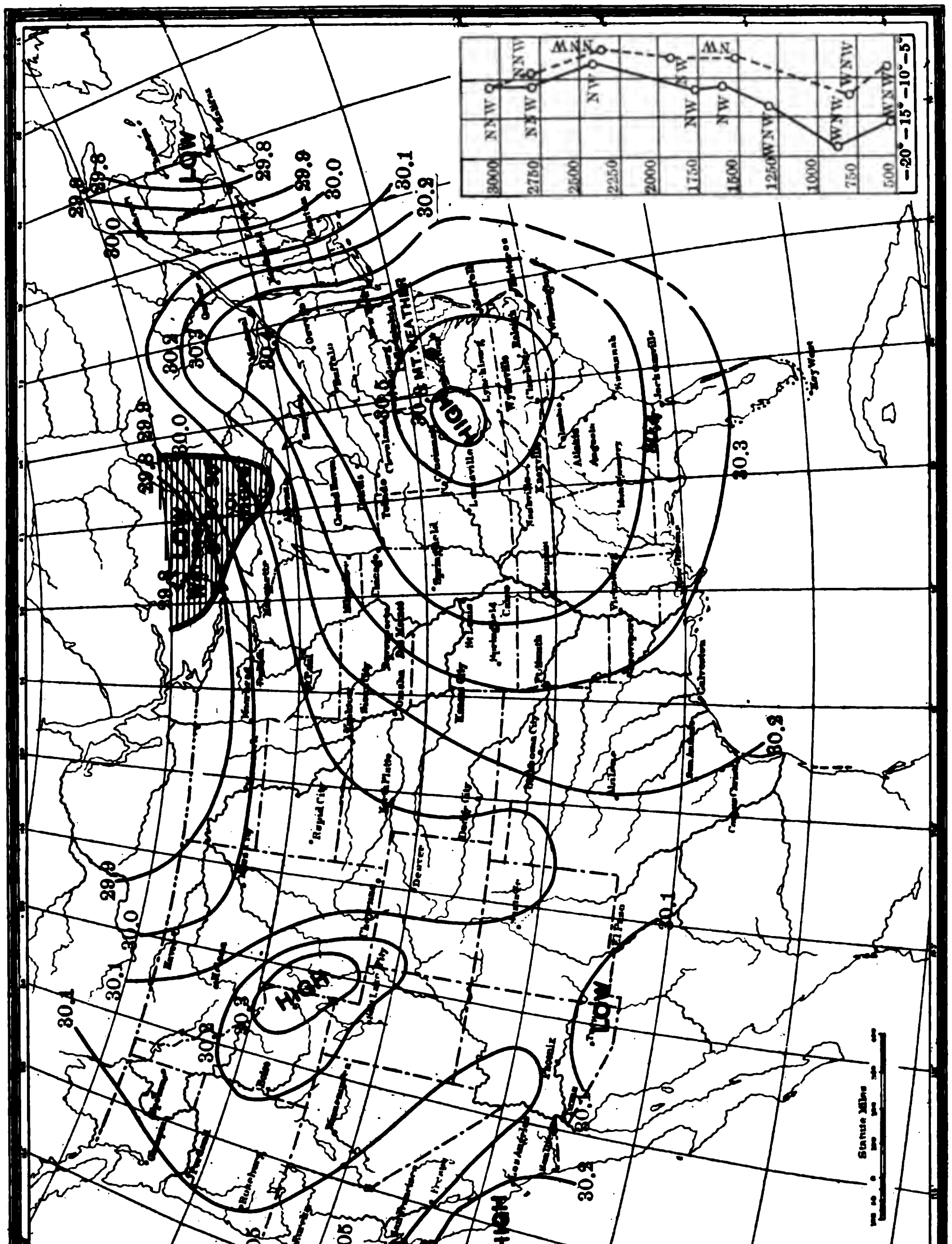

FIG. 5.—Daily weather map for February 7, 1910, with a plot of temperatures from the kite flights of that day.

(II) FREE AIR DATA AT MOUNT WEATHER FOR JANUARY, FEBRUARY, AND MARCH, 1912.

By the Aerial Section, WM. R. BLAIR in charge.

[Dated June 18, 1912.]

In this period of 91 days, 99 free air observations were made, 98 with kites and 1 with a captive balloon. The mean of the highest points reached daily with the kites was 2,925 meters above sea level in January, 2,363 in February, 2,711 in March, and 2,678 in the period. The highest kite flight of the period, 4,550 meters above sea level, was made on March 19. The balloon ascension, 2,170 meters above sea level, was made on January 3.

The prevailing wind direction for each month of this period was northwest. The mean wind velocity was 9.0 meters per second in January, 8.8 in February, 8.4 in March, and 8.7 in the period. The kite flights for this period do not average so high as those of last year by about 200 meters. There were 7 days of the period in which, for one cause or another, attempts to get observations failed. Two attempts were made to obtain 30 to 36 hour series of observations similar to the series of August 16 and 17 and September 12 and 13, 1911. One of these, started on February 8, was only partially successful. After midnight of the 8th the wind fell to 4.5 meters per second and soon afterward to half this velocity, making kite flying impossible. The series of March 1 and 2 was started at 8.20 a. m. of the 1st and continued until 3.10 p. m. of the 2d.

Charts I to VI of the free air isotherms show the usual disturbed winter conditions throughout the period. The almost continuous temperature inversion of the lower condensation layer is interrupted only occasionally and that usually by the descending air columns in the fronts of pressure maxima.

The free air temperatures observed during the three months of this period are considerably lower than normal. A comparison of these temperatures with the five-year means for this station is shown in Table I for all levels up to 4 kilometers.

TABLE I.

Level.	January.			February.			March.		
	5-year mean.	Mean for month.	Differences.	5-year mean.	Mean for month.	Differences.	5-year mean.	Mean for month.	Differences.
	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.
526 meters	− 1.3	− 6.4	− 5.1	− 0.8	− 4.4	− 3.6	4.6	2.3	−2.3
750 meters	− 1.7	− 7.0	− 5.3	− 1.6	− 5.2	− 3.6	3.5	1.0	−2.5
1,000 meters	− 2.0	− 7.4	− 5.4	− 2.4	− 6.1	− 3.7	2.5	0.1	−2.4
1,250 meters	− 2.5	− 7.4	− 4.9	− 2.9	− 6.4	− 3.5	1.6	− 0.2	−1.8
1,500 meters	− 2.9	− 8.0	− 5.1	− 3.4	− 6.3	− 2.9	0.7	− 0.6	−1.3
1,750 meters	− 3.4	− 7.8	− 4.4	− 4.1	− 7.1	− 3.0	− 0.3	− 1.4	−1.1
2,000 meters	− 4.0	− 7.6	− 3.6	− 4.8	− 7.6	− 2.8	− 1.3	− 2.4	−1.1
2,250 meters	− 4.7	− 8.2	− 3.5	− 5.6	− 7.9	− 2.3	− 2.4	− 3.6	−1.2
2,500 meters	− 5.7	− 9.2	− 3.5	− 6.8	− 8.5	− 1.7	− 3.6	− 4.7	−1.1
2,750 meters	− 6.8	−10.4	− 3.6	− 7.8	− 9.6	− 1.8	− 4.9	− 5.9	−1.0
3,000 meters	− 8.2	−11.9	− 3.7	− 9.0	−11.1	− 2.1	− 6.2	− 7.0	−0.8
3,250 meters	− 9.6	−13.4	− 3.8	−10.5	−12.4	− 1.9	− 7.6	− 8.4	−0.8
3,500 meters	−10.9	−14.9	− 4.0	−12.0	−13.6	− 1.6	− 8.9	− 9.8	−0.9
3,750 meters	−12.2	−16.5	− 4.3	−13.3	−14.7	− 1.4	−10.3	−11.2	−0.9
4,000 meters	−13.6	−18.1	− 4.5	−14.8	−16.4	− 1.6	−11.8	−12.4	−0.6

Figures 1, 2, and 3 show the mean hourly temperatures at the mountain and valley stations for the three months of the period, respectively. For comparison with the data shown in these figures, the mean cloudiness for each of the three months is shown in Table II.

TABLE II.

Month.	Number of days.			Mean cloudiness in tenths.
	Clear.	Partly cloudy.	Cloudy.	
January	9	9	13	6.2
February	9	8	12	5.8
March	8	6	17	6.9

The absolute humidities for the winter months, December, January, and February, have been assembled in Table III. The symbols, H_f, H_r, L_f, L_r; $H \rightarrow L$; $L \rightarrow H$; H, and L, in the heading of Table III stand for front of high, rear of high, front of low, rear of low; rising air pressure, i. e., the regions L_r and H_f; falling air pressure, i. e., the regions H_r and L_f; high, and low. The half kilometer levels up to 3 kilometers are represented and the numbers so placed as to make apparent the characteristic change of absolute humidity with altitude in each of the above regions. The distribution of the observations is shown in the columns headed "Number of observations."

For the levels considered, the absolute humidity in the region L_f (usually greater at the earth's surface than in the other regions considered) decreases most rapidly with altitude, while in the region H_r it decreases least rapidly. A characteristic of the winter months, especially in the region H_r, is the increase or slower rate of decrease of the moisture content of the air with altitude. This phenomenon may be observed at all levels up to the 2-kilometer level. It means, of course, a decided increase with altitude in the ratio of the water

content to the whole air mass in a given volume of air and is directly related to the nearly continuous inversion of temperature observed at these levels in the winter months.

A number of formulæ have been devised for approximating the amount of water in the atmosphere over a given area of the earth's surface. These formulæ are based upon an observation of the absolute humidity at the earth's surface. So far as the data in Table III go they indicate that, if these formulæ are applicable to the average of all conditions for a given period of time, they can not be expected to give even approximate results when applied to the particular regions H_f, H_r, L_f, and L_r for the same period of time, much less to smaller areas. The data in Table III, together with those autumn and spring data already reduced, indicate so far as they go that if these formulæ are applicable to mean conditions for a given period of time—say a year—they will not give a good approximation when applied to a particular season of the year, much less to a particular month or day. Such formulæ may be of value as concise approximate expressions of mean conditions, but as such only does their use seem to be legitimate.

THE DIURNAL RANGES OF TEMPERATURE AND OTHER ELEMENTS AT DIFFERENT LEVELS ABOVE MOUNT WEATHER.

The temperature and humidity data obtained in the two series of ascensions, August 16–17, and September 12–13, 1911, have been published in this bulletin, Vol. IV, parts 5 and 6, respectively. In these series, observations were also made of atmospheric electric potentials and of wind direction and velocity.

The kite reel was insulated, and the potentials observed were those of the reel when the kites were at different levels. Table IV shows the corrected values of these potentials for the two series, also the smoothed means for the two series and the departures of these means from the mean for the day. The corrections made eliminate as far as possible the 24-hour changes in potential at the different levels. The values given are hourly, and the smoothing involves actual values for the hour just before and the one just after as well as the actual value at the hour for which the smoothed value is given. Figure 4 also shows the smoothed means of the atmospheric potentials. Departures from the mean are not great at any hour or level, but most negative departures are found between 10 a. m. and 10 p. m.

The wind directions are observed to 16 points only. The velocities recorded by the meteorograph are fairly accurate. The actual wind velocities and directions observed at the different levels in the August 16–17 and September 12–13 series are shown in Table V. These velocities have been resolved into their north and west components and the components corrected from the first to the second day. These are also shown in Table V and, in addition, the smoothed means

of each component for the two series and the departures of these means from the mean for the day. Figures 5 and 6 also show the smoothed means for the two series of the north and west components, respectively. It is hoped that when enough data have been accumulated this method of reducing them will show approximately the diurnal variation to be expected in a given wind direction.

The free air isotherms based upon the observations made February 8, 1912, are shown in figure 7. The data obtained on this occasion have not been further reduced, because the observations made on the 9th do not furnish sufficient basis for the elimination of other than diurnal effects. An interesting fact shown by figure 7 is that in both the ascent and descent of each flight the meteorograph recorded an inversion of temperature. The minimum of temperature at the base of this inversion layer varied from −19.7° C. to −14.4° C, the extremes being observed in successive flights, and was nearly coincident in altitude with the base of the strato-cumulus cloud layer observed in the first flight. A similar inversion of temperature is shown in figure 8, the free air isotherms as observed in the series of March 1 and 2. In the latter series, the base of the strato-cumulus layer also seems to be coincident in altitude with the minimum of temperature at the base of the inversion layer. The amount of these clouds was very variable and some were present during nearly the whole series. Detailed cloud observations are included with the tabulated data. The minimum temperature below the inversion of the March 1–2 series varied from −20.7° C up to −14.4° C. In both figures 7 and 8 the base of the inversion layer is marked by a dashed line. Maxima of altitude in this line of minimum temperature are usually accompanied by minima of temperature, while minima of altitude are usually accompanied by maxima of temperature. The decrease in temperature with altitude from the earth's surface up to the surface of minimum temperature is 0.8° C. to 1.0° C. per 100 meters, or approximately the adiabatic rate.

When the temperatures observed at the half-kilometer levels in the March 1–2 series of kite flights are corrected, smoothed, and charted, Table V and figure 9, the curves are found to have the same general appearance as those in figure 11, this bulletin, Vol. IV, page 388, which represents in a similar way the observations of the two series, August 16–17 and September 12–13, 1911. The departures of the hourly temperatures from the mean for the day are least at a level a little above 1.5 kilometers, and in this series, as in the two previons ones, this level is one of transition from the temperature distribution peculiar to the lower levels to that peculiar to the upper levels for which data are given. As in the first two series, the observed temperatures are nearest the mean for the day at 10 to 11 o'clock in the forenoon, but this coincidence is found at 7 to 8 o'clock in the afternoon in the third series or 3 hours earlier than in the first two series.

At the 1.5 kilometer level and below, the diurnal maximum of temperature is at 3 p. m. as in the first and second series, but from this hour the temperature falls more rapidly in the third than in the first two series. This rapid fall continues until about 9 p. m. after which hour the fall is 2° C. in 10 hours, the minimum being reached at 7 a. m., instead of at 6 a. m. as in the first two series. The rapid fall of temperature in the late afternoon probably means a rapid clearing of the air in the lower stratum, i. e., a rapid increase in its diathermance. The maximum temperature for the day in the upper of the two strata explored is found at 10 to 12 p. m. or just immediately following the rapid fall of temperature above mentioned in the lower stratum. This seems to be the time of day when, the diathermance of the air in the lower stratum and the earth's potential as a radiator considered, the amount of the earth radiation reaching the upper stratum is a maximum. The maximum temperature in the upper of the two strata explored is 3 or 4 hours earlier in the third than in the first two series. This gives the temperature curves of the third series a somewhat different appearance, there being a marked early morning minimum at all levels both above and below the transition level between the two strata.

The explanation suggested for the diurnal temperature distribution observed in the first two series of flights applies equally well to the third series. This explanation, as against the idea of retarded maximum and minimum temperatures at higher levels owing to absorption and reradiation of terrestrial radiation by the air itself, receives additional support in the temperature distribution observed in the third series. This additional support is in the fact that the mean temperature for the day at the 1.5 kilometer level is 1.1° C. lower than that of the level next above it, and that the maximum and minimum temperatures in the two levels differ, respectively, in the same sense by about the same amount.

The absolute humidity observed in the March 1–2 series shows very little variation from the mean value for the day at any level. The observations tabulated in Table VII and plotted in figure 10 have not been corrected or smoothed.

Table VIII and figure 11 show the actual observations of atmospheric potential made in the March 1–2 series. The diurnal variation in this element is much greater than that shown in the first two series and may or may not be characteristic of the season in which the observations were made.

Table IX and figures 12 and 13 show the actual wind observations and also the corrected, smoothed velocities of the north and west components for the March 1–2 series. It is not practicable to observe directions closer than 16 points at night and the irregularities introduced into these data, because of the fact that directions are observed to 16 points only, may eliminate themselves as the number of obser-

vations increases. It is especially true of this element, but true of all the others, that more observations are needed before final conclusions may be drawn either as to the exact nature or amount of their diurnal range characteristic of different seasons and localities.

TABLE III.—*Observations of absolute humidity at Mount Weather for the winter months, 1911 and 1912.*

Months.	Level.	H_t.		H_r.		L_t.		L_r.	
	Km. above Sea level.	Number of observations.	Grams per cubic meter.	Number of observations.	Grams per cubic meter.	Number of observations.	Grams per cubic meter.	Number of observations.	Grams per cubic meter.
December.....	(Sur.) 0.526	10	2.6	5	4.4	5	7.0	3	5.7
	1.0	10	2.2	5	4.5	5	7.7	3	4.4
	1.5	8	2.1	5	4.4	5	6.4	3	3.0
	2.0	5	2.1	5	4.0	5	4.4	3	2.5
	2.5	4	2.0	4	3.8	3	1.9	2	2.5
	3.0	3	1.4	2	2.7	2	1.5	2	2.2
January.......	(Sur.) .526	9	1.8	6	2.0	4	2.4	8	2.7
	1.0	9	1.4	6	2.6	4	2.1	8	2.3
	1.5	9	1.2	6	2.7	4	2.1	8	1.9
	2.0	9	1.1	6	2.7	4	2.0	6	2.1
	2.5	7	1.0	6	2.3	2	0.6	5	1.6
	3.0	6	1.0	6	1.8	2	0.3	2	0.8
February......	(Sur.) .526	9	1.4	4	2.2	5	5.1	7	2.1
	1.0	8	1.1	4	2.0	5	4.6	7	1.6
	1.5	7	1.0	4	1.6	4	4.9	7	1.1
	2.0	5	1.1	3	1.1	3	4.4	6	0.8
	2.5	3	1.0	3	1.0	1	2.1	4	0.6
	3.0	3	0.8	1	1.2	1	1.4	2	0.4
Winter........	(Sur.) .526	28	2.0	15	2.8	14	5.0	18	3.0
	1.0	27	1.6	15	3.1	14	5.0	18	2.4
	1.5	24	1.4	15	3.0	14	4.3	18	1.8
	2.0	19	1.4	14	2.8	12	3.6	15	1.7
	2.5	14	1.3	13	2.4	6	1.5	11	1.4
	3.0	12	1.0	9	1.9	5	1.0	6	1.1

Months.	Level.	H→L.		L→H.		H.		L.		All conditions.	
	Km. above Sea level.	Number of observations.	Grams per cubic meter.	Number of observations.	Grams per cubic meter.	Number of observations.	Grams per cubic meter.	Number of observations.	Grams per cubic meter.	Number of observations.	Grams per cubic meter.
December......	(Sur.) 0.526	13	3.3	10	5.7	15	3.2	8	6.5	23	4.3
	1.0	13	2.7	10	6.3	15	2.9	8	6.5	23	4.2
	1.5	11	2.4	10	5.4	13	3.0	8	5.1	21	3.8
	2.0	8	2.3	10	4.2	10	3.0	8	3.7	18	3.3
	2.5	6	2.2	7	3.0	8	2.9	5	2.1	13	2.6
	3.0	5	1.7	4	2.1	5	1.9	4	1.9	9	1.8
January........	(Sur.) .526	17	2.2	10	2.2	15	1.9	12	2.6	27	2.2
	1.0	17	1.8	10	2.5	15	1.9	12	2.2	27	2.1
	1.5	17	1.5	10	2.5	15	1.8	12	2.0	27	1.9
	2.0	15	1.5	10	2.4	15	1.8	10	2.0	25	1.8
	2.5	12	1.2	8	1.9	13	1.6	7	1.3	20	1.5
	3.0	8	0.9	8	1.4	12	1.4	4	0.6	16	1.2
February.......	(Sur.) .526	16	1.7	9	3.8	13	1.7	12	3.3	25	2.5
	1.0	15	1.3	9	3.4	12	1.4	12	2.9	24	2.1
	1.5	14	1.1	8	3.2	11	1.2	11	2.5	22	1.9
	2.0	11	0.9	6	2.5	8	1.1	9	2.0	17	1.6
	2.5	7	0.8	4	1.3	6	1.0	5	0.9	11	1.0
	3.0	5	0.6	2	1.3	4	0.9	3	0.7	7	0.8
Winter.........	(Sur.) .526	46	2.4	29	3.9	43	2.3	32	3.9	75	3.0
	1.0	45	1.9	29	4.0	42	2.1	32	3.5	74	2.7
	1.5	42	1.6	29	3.6	39	2.1	32	2.9	71	2.4
	2.0	34	1.5	26	3.2	33	2.0	27	2.5	60	2.2
	2.5	25	1.3	19	2.2	27	1.9	17	1.4	44	1.7
	3.0	18	1.1	14	1.6	21	1.4	11	1.1	32	1.3

TABLE IV.—*Atmospheric electric potentials observed at Mount Weather, August 16–17, and September 12–13, 1911.*

Hour.	1,500 meters.					2,000 meters.				
	Corrected.			Smoothed means.	Departures.	Corrected.			Smoothed means.	Departures.
	First series.	Second series.	Means.			First series.	Second series.	Means.		
	Volts.	*Volts.*	*Volts.*	*Volts.*	*Volts.*	*Volts.*	*Volts.*	*Volts.*	*Volts.*	*Volts.*
8 a. m.	510	290	400	380	+120	870	450	660	660	+120
9 a. m.	520	220	370	350	+ 90	850	370	610	600	+ 60
10 a. m.	390	170	280	280	+ 20	740	320	530	520	− 20
11 a. m.	220	130	180	190	− 70	540	300	420	430	−110
12 noon	130	110	120	130	−130	370	310	340	370	−170
1 p. m.	100	100	100	120	−140	350	330	340	350	−190
2 p. m.	140	150	140	150	−110	430	330	380	390	−150
3 p. m.	180	270	220	170	− 90	550	360	460	450	− 90
4 p. m.	90	210	150	150	−110	530	500	520	510	− 30
5 p. m.	0	200	100	140	−120	450	620	540	520	− 20
6 p. m.	20	350	180	180	− 80	360	650	500	510	− 30
7 p. m.	130	370	250	240	− 20	340	610	480	490	− 50
8 p. m.	250	340	300	310	+ 50	390	560	480	500	− 40
9 p. m.	370	380	380	360	+100	450	650	550	530	− 10
10 p. m.	440	380	410	380	+120	490	670	580	550	+ 10
11 p. m.	400	290	340	310	+ 50	500	520	510	530	− 10
12 midnight	40	300	170	230	− 30	490	510	500	520	− 20
1 a. m.	10	370	190	230	− 30	510	600	560	550	+ 10
2 a. m.	270	420	340	290	+ 30	600	570	580	590	+ 50
3 a. m.	350	340	340	320	+ 60	700	530	620	600	+ 60
4 a. m.	350	190	270	320	+ 60	720	500	610	620	+ 80
5 a. m.	550	120	340	320	+ 60	860	400	630	650	+110
6 a. m.	520	200	360	350	+ 90	880	520	700	680	+140
7 a. m.	250	470	360	370	+110	670	750	710	690	+150
Means	260	270	260	....	....	570	500	540	....	....

Hour.	2,500 meters.					3,000 meters.				
	Corrected.			Smoothed means.	Departures.	Corrected.			Smoothed means.	Departures.
	First series.	Second series.	Means.			First series.	Second series.	Means.		
	Volts.	*Volts.*	*Volts.*	*Volts.*	*Volts.*	*Volts.*	*Volts.*	*Volts.*	*Volts.*	*Volts.*
8 a. m.	1,200	660	930	990	+150	1,460	840	1,150	1,220	+ 80
9 a. m.	1,230	580	900	870	+ 30	1,560	790	1,180	1,160	+ 20
10 a. m.	1,020	540	780	810	− 30	1,500	780	1,140	1,140	0
11 a. m.	900	580	740	750	− 90	1,370	820	1,100	1,090	− 50
12 noon	860	620	740	740	−100	1,140	890	1,020	1,080	− 60
1 p. m.	870	610	740	770	− 70	1,200	1,040	1,120	1,110	− 30
2 p. m.	950	700	820	830	− 10	1,250	1,120	1,180	1,140	0
3 p. m.	1,010	840	920	870	+ 30	1,140	1,120	1,130	1,150	+ 10
4 p. m.	1,000	730	860	880	+ 40	1,210	1,060	1,140	1,160	+ 20
5 p. m.	940	760	850	810	− 30	1,460	1,040	1,250	1,170	+ 30
6 p. m.	550	890	720	750	− 90	1,150	1,080	1,120	1,140	0
7 p. m.	490	850	670	680	−160	1,060	1,060	1,060	1,050	− 90
8 p. m.	550	770	660	690	−150	1,060	870	960	1,040	−100
9 p. m.	620	870	740	730	−110	1,100	1,120	1,110	1,090	− 50
10 p. m.	680	930	800	770	− 70	1,130	1,250	1,190	1,140	0
11 p. m.	690	830	760	770	− 70	1,140	1,120	1,130	1,120	− 20
12 midnight	620	860	740	760	− 80	820	1,240	1,030	1,080	− 60
1 a. m.	660	880	770	790	− 50	790	1,350	1,070	1,090	− 50
2 a. m.	800	900	850	860	+ 20	1,050	1,260	1,160	1,150	+ 10
3 a. m.	1,050	860	960	950	+110	1,280	1,140	1,210	1,200	+ 60
4 a. m.	1,310	760	1,040	1,000	+160	1,350	1,120	1,240	1,240	+100
5 a. m.	1,280	730	1,000	1,010	+170	1,540	980	1,260	1,240	+100
6 a. m.	1,160	850	1,000	1,050	+210	1,440	1,000	1,220	1,270	+130
7 a. m.	1,090	1,190	1,140	1,020	+180	1,380	1,290	1,340	1,240	+100
Means	900	780	840	....	....	1,230	1,060	1,140	....	....

TABLE V.—*Wind observations at Mount Weather, August 16–17, and September 12–13, 1911.*

526 METERS (SURFACE).

Hour.	Direction and velocity.				Corrected N. component.		Corrected W. component.		Smoothed means.		Departures.	
	First series.		Second series.		First series.	Second series.	First series.	Second series.	N. component.	W. component.	N. component.	W. component.
		m. p. s.		*m. p. s.*	*m. p. s.*	*m. p. s.*	*m. p. s.*	*m. p. s.*	*m. p. s.*	*m. p. s.*	*m. p. s.*	*m. p. s.*
8 a. m.	wnw.	13.9	wnw.	9.6	3.1	4.3	11.6	7.3	3.7	9.0	-0.3	+1.2
9 a. m.	wnw.	13.2	wnw.	9.2	3.1	3.9	11.2	6.4	3.5	8.7	-0.5	+0.9
10 a. m.	wnw.	11.1	wnw.	9.4	2.5	3.9	9.4	6.7	3.4	8.4	-0.6	+0.6
11 a. m.	wnw.	11.9	wnw.	9.0	3.0	3.7	10.2	6.4	3.2	8.0	-0.8	+0.2
12 noon	wnw.	10.0	wnw.	9.0	2.5	3.4	8.9	6.2	3.1	7.9	-0.9	+0.1
1 p. m.	wnw.	9.1	wnw.	9.0	2.4	3.7	8.3	7.1	3.7	7.7	-0.3	-0.1
2 p. m.	nw.	9.9	wnw.	10.9	5.9	4.5	6.3	9.1	4.5	8.2	+0.5	+0.4
3 p. m.	nw.	7.9	wnw.	15.0	4.8	5.7	5.3	13.0	5.1	8.1	+1.1	+0.3
4 p. m.	nw.	8.8	wnw.	10.8	5.5	4.4	5.7	9.3	4.5	7.5	+0.5	-0.3
5 p. m.	nw.	4.6	wnw.	9.6	2.8	3.9	3.0	8.4	4.3	5.8	+0.3	-2.0
6 p. m.	nw..	3.0	nw.	9.6	1.9	6.9	1.9	6.4	4.3	4.7	+0.3	-3.1
7 p. m.	nnw.	2.7	nw.	10.5	2.5	7.5	0.9	7.3	4.4	4.2	+0.4	-3.6
8 p. m.	nw.	2.0	nw.	9.4	0.9	6.6	1.8	6.6	4.5	4.7	+0.5	-3.1
9 p. m.	wnw.	3.5	nw.	10.8	1.8	7.6	3.6	7.8	4.7	5.8	+0.7	-2.0
10 p. m.	wnw.	6.2	nw.	12.2	2.9	8.5	5.9	8.9	4.2	7.2	+0.2	-0.6
11 p. m.	w.	7.0	nw.	11.8	0.7	3.5	7.3	9.4	3.2	8.3	-0.8	+0.5
12 midnight	w.	7.8	wnw.	8.8	0.9	2.9	8.2	10.3	2.7	9.2	-1.3	+1.4
1 a. m.	w.	10.6	nw.	11.0	1.1	7.4	11.2	8.7	3.4	9.6	-0.6	+1.8
2 a. m.	w.	10.7	nw.	10.0	1.3	6.8	11.3	8.1	3.6	9.4	-0.4	+1.6
3 a. m.	w.	11.2	nw.	5.4	1.5	3.5	12.0	5.0	4.1	9.2	+0.1	+1.4
4 a. m.	wnw.	11.4	nw.	8.5	6.1	5.6	11.4	7.4	4.7	9.1	+0.7	+1.3
5 a. m.	wnw.	11.1	nw.	8.4	6.1	5.3	11.2	7.5	5.9	9.5	+1.9	+1.7
6 a. m.	wnw.	11.5	nw.	8.0	6.4	5.7	11.6	7.5	5.2	9.3	+1.2	+1.5
7 a. m.	w.	8.9	nw.	7.6	2.3	5.4	10.2	7.3	4.5	9.3	+0.5	+1.5
Means	......	......	......	......	3.0	5.1	7.8	7.9	4.0	7.8	......	......

1,000 METERS.

Hour.	Direction and velocity, first series	*m. p. s.*	Direction and velocity, second series	*m. p. s.*	Corrected N. component, first series	Corrected N. component, second series	Corrected W. component, first series	Corrected W. component, second series	Smoothed means, N. component	Smoothed means, W. component	Departures, N. component	Departures, W. component
8 a. m.	nnw.	22.1	wnw.	18.0	13.8	9.7	13.8	9.6	10.6	11.6	+1.0	+0.2
9 a. m.	nw.	18.2	nw.	16.4	9.3	10.1	14.5	7.6	10.1	10.9	+0.5	-0.5
10 a. m.	nw.	15.0	nw.	14.9	7.3	10.2	13.5	6.5	9.1	10.1	-0.5	-1.3
11 a. m.	nw.	14.6	nw.	13.5	7.2	10.3	12.3	6.2	8.8	9.5	-0.8	-1.9
12 noon	nw.	14.7	nw.	13.0	7.6	10.0	12.2	6.5	8.9	9.3	-0.7	-2.1
1 p. m.	nw.	13.0	nw.	14.0	6.9	11.4	10.9	7.5	9.2	9.7	-0.4	-1.7
2 p. m.	nw.	13.1	nw.	16.9	8.2	11.1	9.2	11.6	9.5	10.3	-0.1	-1.1
3 p. m.	nnw.	15.1	wnw.	18.5	12.0	7.7	7.6	15.3	10.3	10.6	+0.7	-0.8
4 p. m.	nnw.	14.1	nw.	18.9	11.5	11.7	5.9	14.3	10.5	10.0	+0.9	-1.4
5 p. m.	nnw.	10.2	nw.	18.5	9.0	13.3	4.8	12.1	10.5	8.7	+0.9	-2.7
6 p. m.	nw.	8.1	nw.	15.7	8.1	11.3	4.6	10.5	10.1	8.0	+0.5	-3.4
7 p. m.	nw.	7.0	nw.	15.2	7.4	11.3	5.2	10.8	9.5	8.4	-0.1	-3.0
8 p. m.	nw.	7.8	nw.	16.1	6.9	11.9	7.4	12.0	9.3	9.7	-0.3	-1.7
9 p. m.	wnw.	10.8	nw.	16.9	6.5	11.9	10.1	12.5	9.2	11.2	-0.4	-0.2
10 p. m.	wnw.	13.4	nw.	16.1	6.5	11.6	11.9	13.2	9.0	12.5	-0.6	+1.1
11 p. m.	wnw.	14.7	nw.	16.0	6.6	11.2	12.6	14.6	8.9	13.2	-0.7	+1.8
12 midnight	wnw.	15.1	nw.	15.5	7.1	10.5	12.5	14.2	8.8	13.1	-0.8	+1.7
1 a. m.	wnw.	15.5	nw.	14.3	7.9	9.7	12.8	12.0	9.0	13.3	-0.6	+1.9
2 a. m.	wnw.	20.0	nw.	12.0	10.0	8.7	16.7	11.5	9.4	13.9	-0.2	+2.5
3 a. m.	wnw.	21.9	nw.	13.6	11.4	8.7	18.0	12.4	10.1	15.2	+0.5	+3.8
4 a. m.	wnw.	23.0	nw.	15.0	12.0	9.8	18.8	14.0	10.4	16.0	+0.8	+4.6
5 a. m.	wnw.	23.2	nw.	13.4	12.2	8.6	18.7	13.9	9.9	15.8	+0.3	+4.4
6 a. m.	wnw.	21.2	nw.	11.9	11.2	7.6	17.2	11.9	9.7	14.4	+0.1	+3.0
7 a. m.	wnw.	20.0	nw.	12.4	10.0	10.5	15.5	9.0	10.1	12.8	+0.5	+1.4
Means	......	......	......	......	9.0	10.3	11.6	11.2	9.6	11.4	......	......

TABLE V.—*Wind observations at Mount Weather, August 16-17, and September 12-13, 1911*—Continued.

1,500 METERS.

Hour.	Direction and velocity.				Corrected N. component.		Corrected W. component.		Smoothed means.		Departures.	
	First series.		Second series.		First series.	Second series.	First series.	Second series.	N. component.	W. component.	N. component.	W. component.
		m.p.s.		m.p.s.	m.p.s.	m.p.s.	m.p.s.	m.p.s.	m.p.s.	m.p.s.	m.p.s.	m.p.s.
8 a. m.	nnw.	20.6	wnw.	18.5	15.7	10.5	12.1	13.4	13.5	11.9	+2.7	−0.1
9 a. m.	nnw.	19.7	nw.	15.9	15.0	11.2	11.4	10.2	13.1	11.1	+2.3	−0.9
10 a. m.	nnw.	18.9	nw.	14.9	14.6	11.5	10.7	8.4	12.6	10.2	+1.8	−1.8
11 a. m.	nnw.	17.6	nw.	15.3	12.3	11.2	11.1	9.5	11.2	12.0	+0.4	0.0
12 noon	nw.	15.8	wnw.	21.0	9.0	8.8	14.0	17.9	9.5	13.7	−1.3	+1.7
1 p. m.	nw.	13.8	wnw.	19.6	8.1	7.7	12.9	16.9	8.4	14.6	−2.4	+2.6
2 p. m.	nw.	14.1	wnw.	19.0	9.0	7.8	9.3	16.7	8.8	13.5	−2.0	+1.5
3 p. m.	nnw.	15.0	wnw.	20.6	11.8	8.7	7.3	18.1	10.1	12.3	−0.7	+0.3
4 p. m.	nnw.	13.2	nw.	19.8	11.1	12.3	7.4	15.2	10.8	11.6	0.0	−0.4
5 p. m.	nw.	12.6	nw.	18.6	7.4	13.5	9.1	12.6	10.7	10.9	−0.1	−1.1
6 p. m.	nw.	11.7	nw.	17.6	7.5	12.7	8.9	12.2	10.3	10.6	−0.5	−1.4
7 p. m.	nw.	11.2	nw.	17.6	7.9	12.7	8.4	12.6	10.3	10.7	−0.5	−1.3
8 p. m.	nw.	10.8	nw.	18.4	7.7	13.1	8.7	13.3	10.2	10.7	−0.6	−1.3
9 p. m.	wnw.	11.0	nw.	17.9	7.0	12.6	8.2	12.9	9.6	10.9	−1.2	−1.1
10 p. m.	wnw.	11.8	nw.	16.4	6.1	11.3	10.0	12.2	8.9	11.0	−1.9	−1.0
11 p. m.	wnw.	13.1	nw.	15.4	6.0	10.6	10.9	11.7	8.5	11.4	−2.3	−0.6
12 midnight	wnw.	15.4	nw.	15.7	6.5	10.7	11.7	11.8	8.6	11.8	−2.2	−0.2
1 a. m.	wnw.	16.6	nw.	16.0	7.3	10.8	12.3	12.4	9.0	12.4	−1.8	+0.4
2 a. m.	wnw.	17.2	nw.	16.2	8.3	10.8	13.2	12.7	9.6	12.9	−1.2	+0.9
3 a. m.	wnw.	19.0	nw.	15.7	10.2	10.5	14.1	12.5	10.7	13.1	−0.1	+1.1
4 a. m.	nw.	20.8	nw.	14.6	14.8	9.5	13.9	12.0	12.1	13.1	+1.3	+1.1
5 a. m.	nw.	22.4	nw.	14.2	18.4	9.1	13.0	11.8	13.3	12.6	+2.5	+0.6
6 a. m.	nw.	22.3	nw.	14.8	19.1	9.4	11.4	12.4	14.0	12.3	+3.2	+0.3
7 a. m.	nw.	21.2	nw.	15.9	18.4	10.1	10.8	13.4	13.8	12.3	+3.0	+0.3
Means	......	......	......	......	10.8	10.7	10.9	13.0	10.8	12.0	......	......

2,000 METERS.

Hour.	First series.		Second series.		Corr. N. first series.	Corr. N. second series.	Corr. W. first series.	Corr. W. second series.	Smoothed N.	Smoothed W.	Departure N.	Departure W.
8 a. m.	nnw.	19.9	nw.	18.9	17.6	14.0	11.9	12.7	15.1	11.5	+3.1	−0.9
9 a. m.	nnw.	18.4	nw.	17.9	16.4	13.8	10.9	10.8	15.2	11.3	+3.2	−1.1
10 a. m.	nnw.	18.1	nw.	17.6	16.1	13.2	10.5	11.1	14.5	11.6	+2.5	−0.8
11 a. m.	nnw.	17.8	nw.	18.7	15.7	11.6	9.8	16.4	13.2	13.1	+1.2	+0.7
12 noon	nnw.	16.5	wnw.	22.6	14.5	8.3	9.4	21.6	11.3	15.1	−0.7	+2.7
1 p. m.	nw.	15.2	wnw.	22.1	10.5	7.6	12.5	20.8	9.9	16.0	−2.1	+3.6
2 p. m.	nw.	14.9	wnw.	21.3	10.7	8.1	11.8	20.0	9.8	15.4	−2.2	+3.0
3 p. m.	nnw.	15.4	wnw.	21.4	13.9	8.1	7.6	20.0	10.3	14.6	−1.7	+2.2
4 p. m.	nnw.	16.3	wnw.	20.9	13.5	7.8	8.9	19.6	10.7	14.3	−1.3	+1.9
5 p. m.	nw.	17.0	wnw.	19.6	12.1	8.7	12.5	17.3	10.9	14.3	−1.1	+1.9
6 p. m.	nw.	16.5	nw.	18.7	11.3	12.0	13.8	13.9	11.4	13.9	−0.6	+1.5
7 p. m.	nw.	15.2	nw.	18.1	11.1	13.3	13.3	12.7	11.8	13.0	−0.2	+0.6
8 p. m.	nw.	14.1	nw.	17.6	10.5	12.6	11.8	12.4	11.6	12.0	−0.4	−0.4
9 p. m.	nw.	13.3	nw.	17.9	9.9	12.5	9.7	12.3	11.6	11.2	−0.4	−1.2
10 p. m.	nw.	12.8	nw.	17.9	9.5	14.9	8.2	12.5	11.5	10.5	−0.5	−1.9
11 p. m.	nw.	12.9	nw.	17.6	9.5	12.6	7.9	12.2	11.8	10.4	−0.2	−2.0
12 midnight	nw.	15.4	nw.	18.0	11.3	13.0	9.1	12.4	11.9	10.8	−0.1	−1.6
1 a. m.	nw.	16.6	nw.	19.0	11.7	13.8	10.0	13.0	11.6	11.0	−0.4	−1.4
2 a. m.	wnw.	15.1	nw.	17.6	7.3	12.6	9.6	12.0	10.5	10.9	−1.5	−1.5
3 a. m.	wnw.	13.4	nw.	16.1	5.9	11.9	9.7	11.0	9.9	10.7	−2.1	−1.7
4 a. m.	wnw.	14.1	nw.	17.2	9.1	12.6	10.5	11.6	11.3	11.1	−0.7	−1.3
5 a. m.	nw.	21.4	nw.	17.4	15.5	12.8	11.6	11.8	13.1	11.4	+1.1	−1.0
6 a. m.	nw.	21.4	nw.	17.0	16.2	12.4	11.4	11.3	14.2	11.5	+2.2	−0.9
7 a. m.	nw.	20.9	nw.	17.6	15.7	12.9	10.5	12.3	14.8	11.7	−2.8	−0.7
Means	......	......	......	......	12.3	11.6	10.6	14.2	12.0	12.4	......	......

TABLE V.—*Wind observations at Mount Weather, August 16–17, and September 12–13, 1911*—Continued.

2,500 METERS.

Hour.	Direction and velocity.				Corrected N. component.		Corrected W. component.		Smoothed means.		Departures.	
	First series.		Second series.		First series.	Second series.	First series.	Second series.	N. component.	W. component.	N. component.	W. component.
		m. p. s.		*m. p. s.*	*m. p. s.*	*m. p. s.*	*m. p. s.*	*m. p. s.*	*m. p. s.*	*m. p. s.*	*m. p. s.*	*m. p. s.*
8 a. m.	nnw.	19.2	nw.	19.6	17.7	16.5	12.4	13.9	15.9	12.5	+2.6	−1.5
9 a. m.	nnw.	17.5	nw.	19.8	16.6	17.6	11.2	14.3	17.1	13.0	+3.8	−1.0
10 a. m.	nnw.	17.2	nw.	21.9	16.4	17.7	10.4	15.4	16.8	13.4	+3.5	−0.6
11 a. m.	nnw.	18.0	nw.	24.0	17.4	15.3	10.8	18.4	16.1	14.8	+2.8	+0.8
12 noon	nnw.	21.5	wnw.	24.4	20.1	10.2	12.1	21.4	14.3	16.5	+1.0	+2.5
1 p. m.	nw.	19.0	wnw.	24.5	13.3	9.7	13.7	22.5	12.4	17.6	−0.9	+3.6
2 p. m.	nw.	16.5	wnw.	23.6	12.1	9.4	13.7	21.8	11.9	16.9	−1.4	+2.9
3 p. m.	nnw.	20.1	wnw.	21.8	18.7	8.6	9.6	19.9	12.7	16.5	−0.6	+2.5
4 p. m.	nnw.	22.1	wnw.	23.5	18.4	9.2	12.3	21.7	14.0	16.9	+0.7	+2.9
5 p. m.	nw.	22.8	wnw.	23.3	16.9	12.2	16.4	21.2	14.2	17.4	+0.9	+3.4
6 p. m.	nw.	21.9	nw.	22.0	14.6	13.8	15.6	17.3	14.0	16.1	+0.7	+2.1
7 p. m.	nw.	18.1	nw.	19.2	12.7	13.9	12.8	13.5	13.1	13.8	−0.2	−0.2
8 p. m.	nw.	16.3	nw.	17.9	11.1	12.7	10.8	12.8	12.2	12.1	−1.1	−1.9
9 p. m.	nw.	14.9	nw.	18.3	9.9	13.0	9.2	13.3	11.7	11.4	−1.6	−2.6
10 p. m.	nw.	14.2	nw.	20.4	9.3	14.2	8.2	14.3	11.9	11.3	−1.4	−2.7
11 p. m.	nw.	14.0	nw.	21.6	9.4	15.2	7.9	15.4	12.6	11.9	−0.7	−2.1
12 midnight	nw.	16.4	nw.	21.6	12.2	15.1	10.2	15.3	13.0	12.5	−0.3	−1.5
1 a. m.	nw.	17.2	nw.	21.0	11.1	14.5	11.3	14.8	12.1	12.8	−1.2	−1.2
2 a. m.	wnw.	16.0	nw.	19.9	6.3	13.7	10.9	14.1	10.8	12.7	−2.5	−1.3
3 a. m.	wnw.	15.4	nw.	19.3	5.9	13.5	11.4	14.0	10.2	13.2	−3.1	−0.8
4 a. m.	wnw.	20.4	nw.	20.0	8.3	13.7	14.3	14.4	11.4	13.6	−1.9	−0.4
5 a. m.	nw.	21.7	nw.	19.5	13.7	13.1	12.9	13.9	12.6	13.2	−0.7	−0.8
6 a. m.	nw.	21.0	nw.	18.6	14.5	12.2	10.2	13.3	13.4	12.3	+0.1	−1.7
7 a. m.	nw.	20.0	nw.	19.0	14.0	13.1	9.6	13.7	14.6	12.2	+1.3	−1.8
Means	......	......	......	......	13.4	13.2	11.6	16.3	13.3	14.0	......	......

3,000 METERS.

8 a. m.	nnw.	19.0	nw.	19.8	18.5	16.3	13.1	15.3	16.1	13.9	+2.1	−1.3
9 a. m.	nnw.	18.0	nw.	20.3	17.5	16.3	12.0	17.1	17.0	14.8	+3.0	−0.4
10 a. m.	nnw.	18.2	nw.	21.7	17.5	15.7	11.5	19.6	16.6	15.8	+2.6	+0.6
11 a. m.	nnw.	19.0	wnw.	24.2	18.2	14.4	11.6	22.7	16.2	17.1	+2.2	+1.9
12 noon	nnw.	19.9	wnw.	26.7	18.9	12.7	11.9	25.1	15.3	18.7	+1.3	+3.5
1 p. m.	nw.	18.3	wnw.	27.8	15.9	11.6	14.8	25.9	13.7	19.8	−0.3	+4.6
2 p. m.	nw.	17.2	wnw.	27.8	12.1	11.0	15.0	26.0	13.3	19.5	−0.7	+4.3
3 p. m.	nnw.	20.4	wnw.	27.6	18.6	10.7	9.4	25.7	13.7	19.3	−0.3	+4.1
4 p. m.	nw.	24.9	wnw.	26.9	19.2	11.1	14.8	24.8	15.5	19.3	+1.5	+4.1
5 p. m.	nw.	25.9	wnw.	25.5	19.1	12.7	19.0	22.3	15.7	19.5	+1.7	+4.3
6 p. m.	nw.	24.3	nw.	23.6	17.3	15.0	18.0	18.5	15.6	17.8	+1.6	+2.6
7 p. m.	nw.	21.1	nw.	20.9	14.9	14.7	14.8	14.6	14.6	15.2	+0.6	0.0
8 p. m.	nw.	18.7	nw.	18.7	12.6	13.0	12.0	13.1	13.2	13.0	−0.8	−2.2
9 p. m.	nw.	17.2	nw.	19.0	10.9	12.9	9.9	13.4	12.4	12.0	−1.6	−3.2
10 p. m.	nw.	16.6	nw.	21.3	10.3	14.7	8.8	15.0	12.6	12.1	−1.4	−3.1
11 p. m.	nw.	16.5	nw.	23.2	10.8	16.1	9.2	16.5	13.3	12.7	−0.7	−2.5
12 midnight	nw.	17.9	nw.	22.7	12.2	15.8	10.4	16.2	13.5	13.2	−0.5	−2.0
1 a. m.	nw.	18.6	nw.	21.4	11.5	14.5	11.7	15.0	12.3	13.3	−1.7	−1.9
2 a. m.	wnw.	18.8	nw.	20.1	6.3	13.3	12.3	14.0	10.8	13.3	−3.2	−1.9
3 a. m.	wnw.	19.2	nw.	20.1	5.8	13.2	12.1	14.2	10.2	13.3	−3.8	−1.9
4 a. m.	wnw.	22.5	nw.	21.6	8.6	14.3	11.4	15.5	11.7	13.2	−2.3	−2.0
5 a. m.	nw.	23.0	nw.	21.0	14.7	13.6	11.5	14.7	13.2	13.0	−0.8	−2.2
6 a. m.	nw.	22.6	nw.	20.5	15.2	12.8	10.8	14.2	14.1	12.8	+0.1	−2.4
7 a. m.	nw.	23.2	nw.	21.3	15.0	13.3	10.9	14.6	15.2	13.2	+1.2	−2.0
Means	......	......	......	......	14.3	13.7	12.3	18.0	14.0	15.2	......	......

TABLE VI.—*Free air temperatures observed at Mount Weather, March 1–2, 1912.*

Hour.	526 meters (surface).			1,000 meters.			1,500 meters.			2,000 meters.			2,500 meters.		
	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.
	°C.	°C.	C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.
8 a. m.	−10.4	−10.2	+2.2	−14.7	−14.6	+1.6	−18.7	−18.6	+1.4	−16.1	−16.1	0.0	−16.2	−16.3	0.0
9 a. m.	− 9.4	− 9.3	+1.3	−14.2	−14.0	+1.0	−18.2	−18.1	+0.9	−15.9	−15.8	−0.3	−15.9	−16.0	−0.3
10 a. m.	− 8.2	− 8.2	+0.2	−13.0	−13.1	+0.1	−17.4	−17.4	+0.2	−15.3	−15.5	−0.6	−15.9	−15.9	−0.4
11 a. m.	− 6.9	− 7.0	−1.0	−12.0	−12.3	−0.7	−16.7	−16.8	−0.4	−15.2	−15.4	−0.7	−15.9	−15.9	−0.4
12 noon.	− 5.8	− 5.8	−2.2	−11.9	−11.6	−1.4	−16.4	−16.3	−0.9	−15.6	−15.6	−0.5	−15.8	−16.1	−0.2
1 p. m.	− 4.8	− 4.9	−3.1	−10.9	−10.9	−2.1	−15.7	−15.5	−1.7	−16.1	−16.4	+0.3	−16.5	−16.2	−0.1
2 p. m.	− 4.1	− 4.2	−3.8	− 9.9	−10.2	−2.8	−14.4	−14.8	−2.4	−17.5	−17.2	+1.1	−16.3	−16.2	−0.1
3 p. m.	− 3.6	− 3.9	−4.1	− 9.7	−10.0	−3.0	−14.2	−14.6	−2.6	−17.9	−17.7	+1.6	−15.9	−15.9	−0.4
4 p. m.	− 3.9	− 4.2	−3.8	−10.3	−10.5	−2.5	−15.1	−15.0	−2.2	−17.7	−17.5	+1.4	−15.6	−15.7	−0.6
5 p. m.	− 5.2	− 5.3	−2.7	−11.4	−11.3	−1.7	−15.8	−15.7	−1.5	−16.8	−16.7	+0.6	−15.6	−15.7	−0.6
6 p. m.	− 6.7	− 6.5	−1.5	−12.1	−12.1	−0.9	−16.3	−16.4	−0.8	−15.6	−16.1	0.0	−16.0	−15.9	−0.4
7 p. m.	− 7.6	− 7.5	−0.5	−12.9	−12.8	−0.2	−17.2	−17.3	+0.1	−15.9	−16.1	0.0	−16.2	−16.1	−0.2
8 p. m.	− 8.3	− 8.1	+0.1	−13.5	−13.3	+0.3	−18.4	−18.0	+0.8	−16.9	−16.4	+0.3	−16.2	−15.9	−0.4
9 p. m.	− 8.7	− 8.7	+0.7	−13.6	−13.5	+0.5	−18.3	−18.1	+0.9	−16.3	−15.7	−0.4	−15.4	−15.4	−0.9
10 p. m.	− 9.0	− 8.9	+0.9	−13.3	−13.5	+0.5	−17.7	−17.6	+0.4	−13.9	−14.5	−1.6	−14.7	−15.0	−1.3
11 p. m.	− 9.1	− 9.2	+1.2	−13.6	−13.7	+0.7	−16.8	−16.9	−0.3	−13.3	−13.7	−2.4	−15.0	−15.4	−0.9
12 mdt.	− 9.4	− 9.4	+1.4	−14.1	−14.0	+1.0	−16.2	−16.8	−0.4	−13.9	−14.0	−2.1	−16.5	−16.2	−0.1
1 a. m.	− 9.8	− 9.7	+1.7	−14.3	−14.2	+1.2	−17.3	−17.4	+0.2	−14.7	−14.8	−1.3	−17.1	−17.0	+0.7
2 a. m.	− 9.9	− 9.9	+1.9	−14.3	−14.3	+1.3	−18.6	−18.3	+1.1	−15.7	−16.0	−0.1	−17.5	−17.4	+1.1
3 a. m.	− 9.9	−10.0	+2.0	−14.4	−14.4	+1.4	−19.0	−18.8	+1.6	−17.6	−17.1	+1.0	−17.7	−17.7	+1.4
4 a. m.	−10.2	−10.1	+2.1	−14.6	−14.5	+1.5	−18.8	−18.7	+1.5	−18.0	−17.7	+1.6	−17.8	−17.7	+1.4
5 a. m.	−10.3	−10.3	+2.3	−14.6	−14.7	+1.7	−18.3	−18.6	+1.4	−17.5	−17.4	+1.3	−17.7	−17.6	+1.3
6 a. m.	−10.5	−10.5	+2.5	−14.8	−14.7	+1.7	−18.6	−18.6	+1.4	−16.7	−16.8	+0.7	−17.3	−17.3	+1.0
7 a. m.	−10.8	−10.6	+2.6	−14.8	−14.8	+1.8	−18.8	−18.7	+1.5	−16.3	−16.4	+0.3	−16.8	−16.8	+0.5
Means.	− 8.0	......	......	−13.0	......	......	−17.2	......	......	−16.1	......	......	−16.3	......	......

TABLE VII.—*Observations of absolute humidity at Mount Weather, March 1–2, 1912.*

[Grams per cubic meter.]

MARCH 1.

Altitude.	9 a. m.	10 a. m.	11 a. m.	12 noon.	1 p. m.	2 p. m.	3 p. m.	4 p. m.	5 p. m.	6 p. m.	7 p. m.	8 p. m.	9 p. m.	10 p. m.	11 p. m.	12 night.
526 meters (surface)	2.1	1.9	1.9	1.8	1.7	1.5	1.3	1.3	1.4	1.6	1.8	1.8	1.6	1.5	1.5	1.5
1,000 meters	1.5	1.5	1.4	1.2	1.1	1.0	1.1	1.1	1.1	1.1	1.1	1.2	1.3	1.2	1.1	1.0
1,500 meters	.....	0.8	0.6	0.6	0.8	0.8	0.8	0.7	0.8	0.9	0.8	0.7	0.7	0.8	0.7	0.5
2,000 meters	.....	0.6	0.4	0.4	0.4	0.6	0.5	0.3	0.4	0.7	0.6	0.3	0.3	0.5	0.6	0.4
2,500 meters	.....	0.5	0.3	0.2	0.4	0.5	0.6	0.3	0.3	0.5	0.4	0.3	0.3	0.4	0.5	0.3

MARCH 2.

Altitude.	1 a. m.	2 a. m.	3 a. m.	4 a. m.	5 a. m.	6 a. m.	7 a. m.	8 a. m.	9 a. m.	10 a. m.	11 a. m.	12 noon.	1 p. m.	2 p. m.	3 p. m.
526 meters (surface)	1.5	1.5	1.5	1.5	1.5	1.6	1.7	1.8	1.7	1.5	1.3	1.6	1.9	1.8	1.5
1,000 meters	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.0	0.9	0.9	0.9	0.8
1,500 meters	0.6	0.9	0.9	0.8	0.8	0.9	0.8	0.8	0.9	0.5	0.3	0.6	0.8	0.6	.....
2,000 meters	0.4	0.7	0.5	0.5	0.7	0.7	0.6	0.6	0.7	0.5	0.2	0.4	0.7	0.5	.....
2,500 meters	0.3	0.5	0.6	0.7	0.7	0.5	0.4	0.4	0.5	0.4	0.3	0.4	0.4	0.2	.....

TABLE VIII.—*Observations of atmospheric potentials at Mount Weather, March 1–2, 1912, expressed in volts.*

MARCH 1.

Altitude.	9 a. m.	10 a. m.	11 a. m.	12 noon.	1 p. m.	2 p. m.	3 p. m.	4 p. m.	5 p. m.	6 p. m.	7 p. m.	8 p. m.	9 p. m.	10 p. m.	11 p. m.	12 night.
1,000 meters......	560	300	180	260	490	430	270	50	30	170	270	290	200	90	150	300
1,500 meters......	.....	1,120	800	820	1,330	1,570	1,560	1,160	1,250	1,560	1,610	1,630	1,640	1,640	1,740	2,700
2,000 meters......	.....	2,450	2,260	2,400	2,890	3,110	3,220	1,850	1,930	2,310	2,750	3,050	3,330	3,620	3,700	3,720
2,500 meters......	.....	3,530	3,420	3,600	3,910	4,270	4,380	3,510	3,770	3,970	4,030	4,120	4,420	4,960	5120	5,270

MARCH 2.

Altitude.	1 a. m.	2 a. m.	3 a. m.	4 a. m.	5 a. m.	6 a. m.	7 a. m.	8 a. m.	9 a. m.	10 a. m.	11 a. m.	12 noon.	1 p. m.	2 p. m.	3 p. m.
1,000 meters......	640	760	680	710	1,010	1,140	1,150	110	10	70	220	730	800	640	240
1,500 meters......	2,910	3,080	3,230	3,200	2,720	3,000	3,100	2,980	2,400	1,490	1,470	1,920	2,030	1,790	.....
2,000 meters......	5,000	6,250	5,620	5,430	5,390	5,560	5,590	5,500	5,200	3,150	2,960	3,200	3,250	2,800	.....
2,500 meters......	6,350	7,350	7,490	7,490	7,680	7,050	6,620	6,370	6,140	5,080	4,160	4,080	4,070	4,110	.....

TABLE IX.—*Wind observations at Mount Weather, March 1–2, 1912.*

526 METERS (SURFACE).

Hour.	Direction and velocity.		Corrected.		Smoothed.		Departures.	
			N. component.	W. component.	N. component.	W. component.	N. component.	W. component.
		m. p. s.	*m. p. s.*	*m. p. s.*	*m. p. s.*	*m. p. s.*	*m. p. s.*	*m. p. s.*
8 a. m..............	nw.	5.2	3.5	3.8	3.5	6.5	−1.5	−4.1
9 a. m..............	wnw.	11.5	4.4	10.0	4.6	9.2	−0.4	−1.4
10 a. m..............	wnw.	15.2	5.8	13.5	4.6	10.4	−0.4	−0.2
11 a. m..............	wnw.	8.9	3.6	7.8	4.3	9.8	−0.7	−0.8
12 noon..............	wnw.	9.6	3.6	8.0	4.1	8.7	−0.9	−1.9
1 p. m..............	wnw.	10.8	5.1	10.4	5.4	8.9	+0.4	−1.7
2 p. m..............	nw.	10.6	7.5	8.2	6.8	10.2	+1.8	−0.4
3 p. m..............	nw.	13.5	7.7	11.9	7.5	12.9	+2.5	+2.3
4 p. m..............	wnw.	19.6	7.3	18.6	7.1	15.3	+2.1	+4.7
5 p. m..............	wnw.	16.4	6.2	15.4	6.3	15.9	+1.3	+5.3
6 p. m..............	wnw.	14.4	5.5	13.7	6.0	14.8	+1.0	+4.2
7 p. m..............	wnw.	16.5	6.4	15.4	6.1	14.9	+1.1	+4.3
8 p. m..............	wnw.	15.0	6.5	15.6	5.8	14.0	+0.8	+3.4
9 p. m..............	wnw.	11.9	4.6	10.9	5.5	13.2	+0.5	+2.6
10 p. m..............	wnw.	14.0	5.4	13.0	5.5	13.3	+0.5	+2.7
11 p. m..............	wnw.	16.9	6.6	15.9	5.7	13.9	+0.7	+3.3
12 midnight..........	wnw.	13.8	5.1	12.7	5.0	11.9	0.0	+1.9
1 a. m..............	wnw.	8.5	3.4	7.0	3.8	8.9	−1.2	−1.7
2 a. m..............	wnw.	7.6	2.8	6.9	3.2	7.3	−1.8	−3.3
3 a. m..............	wnw.	9.0	3.4	8.0	4.3	7.1	−0.7	−3.5
4 a. m..............	nw.	9.4	6.6	6.4	4.6	7.9	−0.4	−2.7
5 a. m..............	wnw.	10.3	3.9	9.2	4.5	7.4	−0.5	−3.2
6 a. m..............	wnw.	7.7	2.9	6.6	3.1	7.2	−1.9	−3.4
7 a. m..............	wnw.	6.8	2.5	5.7	3.0	5.4	−2.0	−5.2
Means.........	....	....	5.0	10.6	....	....	....	....

TABLE IX.—*Wind observations at Mount Weather, March 1–2, 1912*—Continued.

1,000 METERS.

Hour.	Direction and velocity.		Corrected.		Smoothed.		Departures.	
			N. component.	W. component.	N. component.	W. component.	N. component.	W. component.
		m. p. s.	*m. p. s.*	*m. p. s.*	*m. p. s.*	*m. p. s.*	*m. p. s.*	*m. p. s.*
8 a. m.	wnw.	9.6	4.5	9.4	4.5	9.8	−1.7	−1.6
9 a. m.	wnw.	7.5	3.4	7.3	3.7	8.1	−2.5	−3.3
10 a. m.	wnw.	7.7	3.3	7.6	3.4	7.8	−2.8	−3.6
11 a. m.	wnw.	8.1	3.4	8.4	3.5	8.3	−2.7	−3.1
12 noon	wnw.	8.6	3.9	9.0	3.3	8.1	−2.9	−3.3
1 p. m.	wnw.	8.6	2.5	7.0	3.7	7.3	−2.5	−4.1
2 p. m.	nw.	8.8	4.8	6.0	4.4	6.8	−1.8	−4.6
3 p. m.	nw.	11.0	5.9	7.5	5.4	8.9	−0.8	−2.5
4 p. m.	wnw.	14.9	5.4	13.2	5.8	11.6	−0.4	+0.2
5 p. m.	wnw.	16.0	6.1	14.2	7.3	12.6	+1.1	+1.2
6 p. m.	nw.	15.3	10.4	10.3	9.5	11.7	+3.3	+0.3
7 p. m.	nw.	16.3	11.9	10.5	11.6	10.8	+5.4	−0.6
8 p. m.	nw.	17.7	12.5	11.6	12.0	11.9	+5.8	+0.5
9 p. m.	nw.	18.1	11.6	13.7	10.2	13.7	+4.0	+2.3
10 p. m.	wnw.	17.2	6.5	15.7	8.1	15.1	+1.9	+3.7
11 p. m.	wnw.	16.9	6.3	15.9	6.4	15.7	+0.2	+4.3
12 midnight	wnw.	16.7	6.4	15.6	6.1	15.0	−0.1	+3.6
1 a. m.	wnw.	15.1	5.7	13.4	5.7	13.8	−0.5	+2.4
2 a. m.	wnw.	13.3	5.1	12.4	5.4	13.0	−0.8	+1.6
3 a. m.	wnw.	13.9	5.4	13.3	5.5	13.1	−0.7	+1.7
4 a. m.	wnw	14.6	5.9	13.7	5.6	13.2	−0.6	+1.8
5 a. m.	wnw.	13.2	5.6	12.6	5.7	13.0	−0.5	+1.6
6 a. m.	wnw.	13.1	5.5	12.8	5.6	12.7	−0.6	+1.3
7 a. m.	wnw.	13.3	5.6	12.7	5.2	11.6	−1.0	+0.2
Means			6.2	11.4				

1,500 METERS.

Hour.	Direction and velocity.		Corrected.		Smoothed.		Departures.	
			N. component.	W. component.	N. component.	W. component.	N. component.	W. component.
8 a. m.	wnw.	13.6	5.2	12.7	5.4	12.9	−0.3	−0.8
9 a. m.	wnw.	12.2	4.9	11.6	4.9	11.6	−0.8	−2.1
10 a. m.	wnw.	11.3	4.5	10.6	4.6	10.8	−1.1	−2.9
11 a. m.	wnw.	10.8	4.3	10.3	4.4	10.4	−1.3	−3.3
12 noon	wnw.	11.2	4.3	10.4	4.1	9.9	−1.6	−3.8
1 p. m.	wnw.	10.0	3.6	9.0	3.9	9.6	−1.8	−4.1
2 p. m.	wnw.	10.2	3.7	9.3	3.9	9.8	−1.8	−3.9
3 p. m.	wnw.	11.9	4.3	11.0	4.3	10.9	−1.4	−2.8
4 p. m.	wnw.	13.9	4.9	12.5	4.9	12.3	−0.8	−1.4
5 p. m.	wnw.	14.5	5.5	13.3	5.3	13.1	−0.4	−0.6
6 p. m.	wnw.	14.9	5.6	13.6	5.7	14.0	0.0	+0.3
7 p. m.	wnw.	16.4	6.1	15.2	6.3	15.5	+0.6	+1.8
8 p. m.	wnw.	19.1	7.1	17.7	6.8	16.7	+1.1	+3.0
9 p. m.	wnw.	18.6	7.2	17.1	6.9	16.5	+1.2	+2.8
10 p. m.	wnw.	16.1	6.4	14.8	6.6	15.9	+0.9	+2.2
11 p. m.	wnw	17.2	6.3	15.8	6.8	16.3	+1.1	+2.6
12 midnight	wnw.	19.8	7.6	18.2	7.0	16.6	+1.3	+2.9
1 a. m.	wnw.	17.1	7.1	15.9	6.7	15.8	+1.0	+2.1
2 a. m.	wnw.	14.5	5.4	13.3	6.1	14.3	+0.4	+0.6
3 a. m.	wnw.	15.1	5.7	13.7	5.8	14.2	+0.1	+0.5
4 a. m.	wnw.	16.6	6.3	15.6	6.3	15.3	+0.6	+1.6
5 a. m.	wnw.	17.8	6.9	16.5	6.7	16.0	+1.0	+2.3
6 a. m.	wnw.	17.0	6.8	15.9	6.6	15.6	+0.9	+1.9
7 a. m.	wnw.	15.4	6.0	14.4	6.0	14.3	+0.3	+0.6
Means			5.7	13.7				

TABLE IX.—*Wind observations at Mount Weather, March 1–2, 1912*—Continued.

2,000 METERS.

Hour.	Direction and velocity.		Corrected.		Smoothed.		Departures.	
			N. component.	W. component.	N. component.	W. component.	N. component.	W. component.
		m. p. s.	m. p. s.	m. p. s.	m. p. s.	m. p. s.	m. p. s.	m. p. s.
8 a. m.	wnw.	20.2	8.4	19.3	8.3	19.5	+0.6	+1.0
9 a. m.	wnw.	19.2	7.9	18.8	7.7	17.9	0.0	−0.6
10 a. m.	wnw.	16.5	6.8	15.8	7.0	16.8	−0.7	−1.7
11 a. m.	wnw.	15.9	6.3	15.8	6.7	16.6	−1.0	−1.9
12 noon	wnw.	18.0	6.9	18.3	6.5	15.9	−1.2	−2.6
1 p. m.	wnw.	18.1	6.3	13.7	5.9	14.2	−1.8	−4.3
2 p. m.	wnw.	13.1	4.5	10.5	5.0	11.7	−2.7	−6.8
3 p. m.	wnw.	12.6	4.3	10.9	5.2	12.6	−2.5	−5.9
4 p. m.	wnw.	18.6	6.9	16.5	6.6	16.1	−1.1	−2.4
5 p. m.	wnw.	23.1	8.5	20.8	8.2	19.2	+0.5	+0.7
6 p. m.	wnw.	24.6	9.1	22.2	8.9	21.5	+1.2	+3.0
7 p. m.	wnw.	24.3	9.0	21.6	8.9	21.5	+1.2	+3.0
8 p. m.	wnw.	22.7	8.5	20.6	8.6	20.7	+0.9	+2.2
9 p. m.	wnw.	22.0	8.2	19.9	8.3	20.1	+0.6	+1.6
10 p. m.	wnw.	21.7	8.1	19.7	8.1	19.6	+0.4	+1.1
11 p. m.	wnw.	21.2	8.1	19.3	8.0	19.1	+0.3	+0.6
12 midnight	wnw.	20.1	7.7	18.4	7.6	18.4	−0.1	−0.1
1 a. m.	wnw.	18.9	7.1	17.4	7.2	17.6	−0.5	−0.9
2 a. m.	wnw.	18.4	6.9	17.1	7.4	18.1	−0.3	−0.4
3 a. m.	wnw.	21.3	8.2	19.9	8.2	20.0	+0.5	+1.5
4 a. m.	wnw.	23.7	9.6	22.9	9.2	22.1	+1.5	+3.6
5 a. m.	wnw.	24.6	9.8	23.4	9.6	22.9	+1.9	+4.4
6 a. m.	wnw.	23.3	9.3	22.4	9.3	22.0	+1.6	+3.5
7 a. m.	wnw.	21.4	8.7	20.3	8.8	20.7	+1.1	+2.2
Means	....		7.7	18.5	....	....	....	....

2,500 METERS.

Hour.	Direction and velocity.		Corrected N. component.	Corrected W. component.	Smoothed N. component.	Smoothed W. component.	Departures N. component.	Departures W. component.
8 a. m.	wnw.	25.4	10.7	24.9	10.5	24.8	+1.4	+3.3
9 a. m.	wnw.	24.7	10.2	24.9	9.9	23.7	+0.8	+2.0
10 a. m.	wnw.	21.1	8.8	21.2	8.9	21.6	−0.2	−0.1
11 a. m.	wnw.	18.5	7.8	18.7	8.7	19.6	−0.4	−2.1
12 noon	wnw.	18.4	7.7	18.8	8.3	19.0	−0.8	−2.7
1 p. m.	wnw.	24.0	9.4	19.6	8.6	19.1	−0.5	−2.6
2 p. m.	wnw.	22.6	8.7	18.9	8.9	19.7	−0.2	−2.0
3 p. m.	wnw.	24.2	8.6	20.5	8.9	20.5	−0.2	−1.2
4 p. m.	wnw.	25.6	9.4	22.0	9.2	21.6	+0.1	−0.1
5 p. m.	wnw.	25.4	9.5	22.3	9.4	22.0	+0.3	+0.3
6 p. m.	wnw.	24.8	9.2	21.8	9.2	21.8	+0.1	+0.1
7 p. m.	wnw.	24.3	8.9	21.3	9.1	21.5	0.0	−0.2
8 p. m.	wnw.	24.1	9.1	21.5	9.0	21.4	−0.1	−0.3
9 p. m.	wnw.	23.8	9.1	21.5	9.1	21.4	0.0	−0.3
10 p. m.	wnw.	23.4	9.0	21.2	8.9	21.1	−0.2	−0.6
11 p. m.	wnw.	22.7	8.6	20.6	8.6	20.6	−0.5	−1.1
12 midnight	wnw.	22.0	8.3	19.9	8.3	19.9	−0.8	−1.8
1 a. m.	wnw.	21.6	8.1	19.3	8.2	19.6	−0.9	−2.1
2 a. m.	wnw.	21.6	8.2	19.7	8.3	20.3	−0.8	−1.4
3 a. m.	wnw.	22.5	8.7	21.9	8.8	22.1	−0.3	+0.4
4 a. m.	wnw.	24.0	9.4	24.7	9.4	24.0	+0.3	+2.3
5 a. m.	wnw.	25.4	10.0	25.5	9.9	25.1	+0.8	+3.4
6 a. m.	wnw.	26.1	10.3	25.0	10.3	25.1	+1.2	+3.4
7 a. m.	wnw.	25.9	10.6	24.7	10.5	24.9	+1.4	+3.2
Means	....	....	9.1	21.7	....	....	....	....

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Jan. 1, 1912:											
First flight—	*mm.*	*C.*	*%*		*m. p. s.*	*m.*	*mm.*	*C.*	*%*		*m. p. s.*
10.34 a. m...	716.2	−2.6	60	nw.	13.4	526	716.2	− 2.6	60	nw.	13.4
10.38 a. m...	716.3	−2.6	60	nw.	12.1	959	678.2	− 5.1	53	wnw.	20.0
10.52 a. m...	716.5	−2.4	60	nw.	12.1	1,133	663.4	− 5.6	45	wnw.	20.6
11.05 a. m...	716.6	−2.6	62	wnw.	14.8	1,608	625.1	1.0	41	wnw.	21.4
11.12 a. m...	716.6	−2.6	60	nw.	14.8	1,879	604.2	0.3	39	wnw.	24.0
11.20 a. m...	716.5	−2.5	60	wnw.	13.4	2,107	587.3	− 1.5	38	wnw.	25.3
11.35 a. m...	716.5	−2.4	58	wnw.	12.1	2,380	567.3	− 2.0	36	wnw.	26.8
11.52 a. m...	716.4	−2.3	57	wnw.	10.3	1,992	595.1	− 1.1	35	wnw.	26.8
11.57 a. m...	716.4	−2.2	57	wnw.	13.0	1,781	611.1	− 1.4	35	wnw.	22.8
11.58 a. m...	716.4	−2.2	57	wnw.	14.8	1,706	616.9	− 3.0	35	wnw.	22.8
12.08 p. m..	716.4	−2.1	58	wnw.	16.5	1,513	632.1	− 2.3	39	wnw.	24.4
12.17 p. m..	716.4	−2.1	59	nw.	13.0	1,176	659.7	− 5.7	47	wnw.	23.2
12.29 p. m..	716.4	−2.0	59	nw.	9.8	916	681.9	− 5.4	55	wnw.	20.8
12.35 p. m..	716.4	−2.1	57	wnw.	9.8	526	716.4	− 2.1	57	wnw.	9.8
Second flight—											
2.14 p. m..	716.4	−1.2	54	nw.	10.7	526	716.4	− 1.2	54	nw.	10.7
2.25 p. m..	716.4	−1.4	60	wnw.	9.4	1,208	657.2	− 5.5	52	wnw.	17.6
2.34 p. m..	716.5	−1.6	61	nw.	10.3	1,486	634.7	− 1.5	48	wnw.	18.8
2.44 p. m..	716.5	−1.6	60	nw.	10.7	1,931	600.1	− 3.5	44	wnw.	19.3
2.57 p. m..	716.5	−1.6	62	nw.	7.6	2,683	545.6	− 4.7	41	wnw.	18.4
3.16 p. m..	716.6	−1.6	60	nw.	9.4	3,447	494.7	−10.7	40	w.	21.6
3.47 p. m..	716.9	−1.8	63	nw.	9.4	4,151	450.7	−16.8	40	wsw.	....
4.20 p. m..	717.3	−2.0	63	nw.	8.0	3,532	488.7	−13.0	39	wsw.	....
4.43 p. m..	717.4	−2.2	63	nw.	5.4	2,817	536.0	− 5.3	38	wnw.	....
4.47 p. m..	717.5	−2.2	63	nw.	5.8	2,512	557.5	− 6.6	38	wnw.	....
5.00 p. m..	717.5	−2.3	64	wnw.	7.2	1,772	612.6	− 4.4	39	wnw.	....
5.02 p. m..	717.5	−2.4	64	wnw.	7.2	1,626	624.1	− 6.8	39	wnw.	....
5.09 p. m..	717.5	−2.5	64	nw.	7.6	1,293	651.2	− 5.8	44	wnw.	....
5.18 p. m..	717.5	−2.6	66	wnw.	6.7	932	681.7	− 3.5	54	wnw.	....
5.23 p. m..	717.5	−2.8	66	wnw.	6.7	526	717.5	− 2.8	66	wnw.	6.7
Jan. 2, 1912:											
8.49 a. m...	719.3	−3.4	73	se.	8.0	526	719.3	− 3.4	73	se.	8.0
8.52 a. m...	719.3	−3.3	73	se.	8.0	730	700.9	− 4.2	76	ssw.	10.5
9.00 a. m...	719.3	−3.1	76	se.	8.0	951	681.6	− 2.0	65	ssw.	9.3
9.26 a. m...	719.3	−2.8	69	se.	8.5	1,650	623.9	− 6.0	70	sw.	13.2
10.38 a. m...	719.1	−2.4	79	se.	7.6	3,194	511.5	− 9.3	49	wsw.	21.8
10.55 a. m...	718.9	−0.8	71	se.	8.0	3,492	492.0	−11.6	77	wsw.	27.8
11.18 a. m...	718.7	−0.6	70	ese.	6.7	2,984	525.4	−10.2	80	wsw.	18.9
11.33 a. m...	718.6	−0.2	67	se.	7.2	2,495	559.6	− 7.1	75	wsw.	21.6
11.47 a. m...	718.4	−0.4	66	se.	7.2	2,002	595.7	− 6.1	47	wsw.	11.8
11.59 a. m...	718.3	−0.0	67	se.	7.2	1,579	628.8	− 5.4	39	wsw.	9.8
12.11 p. m..	718.1	−0.5	66	se.	6.7	1,287	652.4	− 4.9	50	sw.	10.0
12.22 p. m..	717.9	0.0	63	se.	6.3	924	682.9	− 2.0	50	ssw.	9.1
12.25 p. m..	717.9	−0.5	64	se.	6.3	703	702.2	− 3.1	50	ssw.	9.1
12.28 p. m..	717.8	−1.0	65	se.	6.7	526	717.8	− 1.0	65	se.	6.7

January 1, 1912.—First flight: Two kites were used; lifting surface, 10.8 sq. m. Wire out, 4,000 m.; at maximum altitude. 3,600 m.

The sky was covered with Ci.-St., from the west-southwest, and A.-St., from the southwest. Solar halo after 11.50 a. m.

Second flight: Four kites were used; lifting surface, 25.2 sq. m. Wire out, 7,000 m.; at maximum altitude, 6,400 m.

There were 10/10 Ci.-St. and A.-St., from the southwest, until 5 p. m.; these diminished to 2/10 by the end of the flight. Solar halo until 2.30 p. m.

At 8 a. m. low pressure (751 mm.) was central over New Brunswick, high pressure (769 mm.) over Kentucky

January 2, 1912.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 4,500 m.; at maximum altitude, 4,400 m.

Ci. from the west, and Ci-St. and Ci-Cu. from the westsouth-west increased from a few before 11 a. m. to 7/10 at noon.

High pressure (769 mm.) was central over the middle Atlantic coast. Low pressure was central over the western Gulf of Mexico (760 mm.), and north of Lake Huron (762 mm.).

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Jan. 3, 1912:	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%		*m. p. s.*
2.35 p. m....	713.9	−1.2	80	n.	3.1	526	713.9	−1.2	80	n.	3.1
2.49 p. m....	713.7	−1.2	80	ne.	2.7	2,170	578.7	−8.2	......	w.	....
3.05 p. m....	713.6	−1.2	78	n.	0.9	1,747	610.8	−6.2	......	wsw.	....
3.29 p. m....	713.9	−2.0	96	w.	1.8	1,361	642.0	−7.8	......	n.	....
3.30 p. m....	714.0	−2.1	97	nw.	1.8	946	677.0	−5.1	......	n.	....
3.43 p. m....	714.0	−2.0	98	nw.	1.8	526	714.0	−2.0	98	nw.	1.8
Jan. 4, 1912:											
First flight—											
9.47 a. m...	713.6	−4.6	84	wnw.	7.2	526	713.6	− 4.6	84	wnw.	7.2
9.56 a. m...	713.6	−4.3	84	wnw.	6.3	891	681.2	− 6.5	82	wnw.	9.8
11.00 a. m...	713.0	−3.4	82	wnw.	2.7	1,496	629.6	−11.3	79	wnw.	8.7
11.46 a. m..	712.2	−2.4	75	wnw.	2.2	1,917	595.3	−11.5	55	w.	12.0
11.52 a. m...	712.1	−2.1	76	w.	1.8	1,321	643.3	−10.7	65	w.	12.0
12.01 p. m...	712.0	−1.8	67	w.	1.8	526	712.0	− 1.8	67	w.	1.8
Second flight—											
2.22 p. m....	710.4	−1.4	64	sw.	5.4	526	710.4	− 1.4	64	sw.	5.4
2.33 p. m....	710.3	−1.5	64	sw.	6.3	916	676.0	− 5.6	63	sw.	9.6
2.49 p. m....	710.3	−1.2	65	sw.	5.8	1,460	630.4	−11.1	69	wsw.	12.3
3.10 p. m....	710.1	−1.3	68	sw.	2.2	1,808	602.0	−14.1	78	wsw.	12.3
3.16 p. m....	710.1	−1.2	71	s.	2.2	2,171	574.1	−15.9	79	wsw.	16.2
3.20 p. m....	710.1	−1.1	73	se.	2.2	2,378	558.4	−15.9	78	wsw.	21.1
3.35 p. m....	710.0	−1.3	75	s.	3.6	2,799	527.5	−20.2	69	wsw.	17.2
3.37 p. m....	709.9	−1.4	75	s.	3.6	2,868	522.8	−20.0	68	wsw.	17.2
3.48 p. m....	709.9	−1.8	77	s.	4.5	3,393	486.8	−22.7	59	wsw.	25.2
3.53 p. m....	709.8	−1.8	79	s.	3.6	3,465	482.2	−22.2	40	wsw.	29.6
3.55 p. m....	709.8	−1.8	79	s.	3.6	3,511	478.9	−22.5	37	wsw.	29.6
3.57 p. m....	709.8	−1.8	79	s.	3.6	3,458	482.2	−22.0	35	wsw.	29.6
3.59 p. m....	709.8	−1.9	79	s.	4.0	3,419	484.5	−23.1	32	wsw.	28.6
4.12 p. m....	709.8	−2.1	81	ssw.	4.0	3,194	499.5	−21.7	26	wsw.	27.1
4.30 p. m....	709.7	−2.3	82	ssw.	4.0	2,724	532.2	−21.7	59	wsw.	21.1
4.54 p. m....	709.6	−2.2	81	s.	4.0	1,879	595.8	−14.6	84	wsw.	13.2
5.07 p. m....	709.5	−2.3	83	ssw.	4.5	1,417	633.0	−11.2	85	sw.	12.0
5.18 p. m....	709.3	−2.4	83	ssw.	4.5	949	672.2	− 6.6	81	sw.	11.8
5.24 p. m....	709.2	−2.6	82	ssw.	4.9	526	709.2	− 2.6	82	ssw.	4.9

January 3, 1912.—One captive balloon was used; capacity, 31.1 cu. m. Wire out, 2,500 m.

The sky was covered with A.-St. and St.-Cu. from the west before 3.10 p. m. and with St.-Cu. from the same direction thereafter; altitude of St.-Cu., 2,100 m.

Pressure was low (759 mm.) over the Gulf of Mexico and high (770 mm.) over Nebraska.

January 4, 1912.—*First flight:* Four kites were used; lifting surface, 25.2 sq. m. Wire out, 2,400 m.; at maximum altitude, 1,700 m.

St.-Cu., from the west-northwest, decreased from 8/10 to none by 11.45 a. m. Ci. appeared about 11.45 a. m. and increased to 3/10. There was light haze.

Second flight: Three kites were used; lifting surface, 23.8 sq. m. Wire out, 5,000 m.; at maximum altitude, 4,600 m.

There were 3/10 to 10/10 St.-Cu., from the west-southwest, the altitude of whose base varied from 1,300 m. to 2,500 m. Few to 3/10 Ci. from the west were visible between 3.30 and 4 p. m. Light snow fell from 4.48 to 5.12 p. m. There was light haze.

Low pressure was central north of the upper Lakes (754 mm.) and off the North Atlantic States (757 mm.). A ridge of relatively high pressure (766 mm.) extended from the middle St. Lawrence Valley to Florida.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind. Direction.	Wind. Velocity.	Height.	Pressure.	Temperature.	Rel. hum.	Wind. Direction.	Wind. Velocity.
Jan. 5, 1912:	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%		*m. p. s.*
1.46 p. m...	711.2	−16.2	48	wnw.	29.5	526	711.2	−16.2	48	wnw.	29.5
1.54 p. m...	711.2	−16.6	47	wnw.	26.8	900	....	−21.6	47	nw.	....
2.04 p. m...	711.3	−16.2	48	wnw.	27.7	1,186	....	−24.6	48	wnw.	....
2.23 p. m...	711.8	−17.0	45	wnw.	25.9	1,419	....	−27.5	50	wnw.	....
2.33 p. m...	712.1	−16.7	47	wnw.	22.4	1,566	....	−27.8	54	wnw.	....
2.58 p. m...	712.8	−16.0	49	wnw.	23.2	1,186	....	−24.3	57	wnw.	....
3.15 p. m...	713.0	−16.9	45	wnw.	25.9	931	....	−21.1	58	wnw.	....
3.31 p. m...	713.2	−16.6	47	wnw.	26.8	526	713.2	−16.6	47	wnw.	26.8
Jan. 6, 1912:											
8.15 a. m...	722.8	−19.0	74	w.	7.6	526	722.8	−19.0	74	w.	7.6
8.25 a. m...	722.7	−19.0	74	w.	7.2	854	691.3	−22.1	72	wnw.	11.2
8.47 a. m...	722.6	−17.9	70	w.	5.8	1,497	633.2	−23.9	66	nw.	11.3
9.00 a. m...	722.6	−17.7	66	w.	6.7	2,036	589.1	−14.1	45	wnw.	26.2
9.12 a. m...	722.8	−17.9	69	w.	7.6	2,746	536.6	−13.5	48	w.	29.1
9.16 a. m...	722.8	−18.0	70	w.	7.6	2,982	520.2	−14.7	57	w.	34.3
9.20 a. m...	722.9	−17.8	64	w.	8.0	2,728	537.8	−13.4	59	w.	34.3
10.00 a. m...	723.4	−17.2	67	wnw.	7.2	2.166	579.4	−13.7	63	w.	23.5
10.12 a. m...	723.4	−16.8	62	w.	8.5	1,655	620.7	−24.1	43	nw.	11.8
10.20 a. m...	723.3	−16.5	62	w.	7.2	1,323	649.4	−23.0	43	nw.	9.5
10.29 a. m...	723.3	−16.4	62	wnw.	6.7	795	697.7	−20.2	47	wnw.	7.1
10.33 a. m...	723.3	−16.4	62	wnw.	6.7	526	723.3	−16.4	62	wnw.	6.7
Jan. 7, 1912:											
First flight—											
10.08 a. m...	715.8	−11.7	92	wnw.	5.8	526	715.8	−11.7	92	wnw.	5.8
10.20 a. m...	715.7	−11.4	93	wnw.	6.3	1,026	670.5	−12.8	92	w.	18.6
10.28 a. m...	715.7	−11.5	94	wnw.	6.7	1,480	631.6	−15.4	92	wnw.	26.5
10.36 a. m...	715.7	−11.5	96	wnw.	8.0	1,677	615.5	−11.6	64	wnw.	31.4
10.56 a. m...	715.6	−11.1	89	wnw.	8.9	1,360	641.5	−15.1	68	wnw.	26.3
11.10 a. m...	715.5	−10.8	86	wnw.	8.9	1,009	671.7	−14.2	77	w.	19.6
11.16 a. m...	715.5	−10.4	87	wnw.	9.8	526	715.5	−10.4	87	wnw.	9.8
Second flight—											
11.25 a. m...	715.4	−10.4	79	wnw.	8.5	526	715.4	−10.4	79	wnw.	8.5
11.35 a. m...	715.4	−10.0	74	wnw.	8.9	895	681.9	−12.6	78	wnw.	17.6
11.52 a. m...	715.2	−10.0	74	wnw.	10.3	1,210	654.0	−14.5	79	w.	20.6
12.01 p. m...	715.2	− 9.6	68	wnw.	10.3	1,715	611.8	−16.2	74	wnw.	36.3
12.13 p. m...	715.2	− 9.5	68	wnw.	10.3	2,115	580.3	−12.9	32	wnw.	40.6
12.17 p. m...	715.2	− 9.5	68	wnw.	10.3	2,331	563.6	−13.7	27	wnw.	41.2
12.32 p. m...	715.2	− 9.7	66	wnw.	9.8	2,040	585.2	−13.1	19	wnw.	34.4
12.57 p. m...	715.2	− 9.9	66	nw.	10.7	1,705	611.8	−19.4	35	w.	28.7
1.15 p. m...	715.2	−10.1	64	nw.	10.3	1,189	655.3	−16.3	54	wnw	21.6
1.28 p. m...	715.2	−10.1	60	nw.	11.6	861	684.5	−14.7	63	nw.	15.7
1.32 p. m...	715.2	−10.2	67	nw.	13.9	526	715.2	−10.2	67	nw.	13.9

January 5, 1912.—One kite was used; lifting surface, 5.4 sq. m. Wire out, 2,500 m., at maximum altitude.

St., from the west-northwest, varied from 6/10 to 9/10.

Low pressure (748 mm.), was central over the New England coast. High pressure (781 mm.) was central over South Dakota.

January 6, 1912.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 4,000 m., at maximum altitude.

There were a few to 7/10 Ci. from the west after 8.40 a. m.

A low (737 mm.) was central over Newfoundland. Pressure was high (776 mm.) over West Virginia.

January 7, 1912.—First flight: Two kites were used; lifting surface, 12.6 sq. m. Wire out, 2,500 m., at maximum altitude.

There were a few St.-Cu. from the west-northwest and light haze.

Second flight: Two kites were used; lifting surface, 10.7 sq. m. Wire out, 3,500 m., at maximum altitude.

There were a few St.-Cu. from the west-northwest, light haze and, after 12.45 p. m., a few Ci. from the west.

High pressure, with centers over Indiana (775 mm.) and New England (770 mm.) covered the United States east of the Rocky Mountains.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Jan. 8, 1912:	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%		*m. p. s.*
8.05 a. m...	719.3	−15.8	80	se.	13.4	526	719.3	−15.8	80	se.	13.4
8.07 a. m...	719.3	−15.8	80	se.	13.4	668	705.8	−16.1	81	s.	20.6
8.10 a. m...	719.2	−15.8	80	se.	13.4	935	681.3	−14.2	76	s.	18.1
8.21 a. m...	719.2	−15.6	78	se.	11.2	1,640	622.3	− 0.7	50	s.	27.4
8.32 a. m...	719.1	−15.0	74	se.	11.6	2,236	577.3	− 4.7	33	ssw.	31.4
8.45 a. m...	719.1	−15.2	72	se.	12.1	2,705	543.9	− 5.2	30	ssw.	18.6
9.00 a. m...	719.0	−14.8	72	se.	12.1	3,014	522.8	− 7.1	29	sw.	19.1
9.15 a. m...	719.0	−14.8	72	se.	12.5	2,724	542.7	− 5.4	29	sw.	23.5
9.27 a. m...	719.0	−14.8	78	se.	13.0	2,536	555.8	− 5.0	27	sw.	25.5
9.40 a. m...	718.9	−14.9	81	se.	13.0	2,321	571.3	− 6.6	31	ssw.	32.4
9.52 a. m...	718.9	−14.5	82	se.	13.0	2,141	584.6	− 6.2	64	ssw.	25.6
10.07 a. m...	718.8	−14.5	82	se.	13.4	1,661	621.0	− 1.6	76	ssw.	29.5
10.18 a. m...	718.6	−14.2	82	se.	11.2	1,457	637.1	− 3.2	74	ssw.	28.3
10.26 a. m...	718.5	−14.2	82	se.	11.2	974	677.5	−11.2	66	s.	21.4
10.34 a. m...	718.3	−14.2	82	se.	11.6	857	687.7	−10.7	58	s.	23.4
10.38 a. m...	718.2	−14.2	82	se.	11.6	672	704.5	−15.2	71	s.	18.5
10.43 a. m...	718.1	−14.2	82	se.	11.2	526	718.1	−14.2	82	se.	11.2
Jan. 9, 1912:											
8.48 a. m...	704.8	−14.0	64	wnw.	11.6	526	704.8	−14.0	64	wnw.	11.6
8.57 a. m...	705.1	−13.6	62	wnw.	12.1	871	673.5	−17.7	62	w.	25.5
9.10 a. m...	705.2	−13.4	59	w.	15.2	1,231	641.7	−21.4	67	wnw.	26.5
10.17 a. m...	705.3	−12.8	50	wnw.	27.3	1,693	603.0	−22.0	73	w.	....
10.48 a. m...	705.4	−12.4	52	wnw.	26.8	1,194	645.5	−20.0	73	wnw.	....
11.05 a. m...	705.5	−12.0	54	wnw.	26.8	877	673.5	−16.9	65	wnw.	....
11.16 a. m...	705.5	−11.8	54	wnw.	26.8	526	705.5	−11.8	54	wnw.	26.8
Jan. 10, 1912:											
First flight—											
8.10 a. m...	715.5	− 9.8	57	wsw.	7.2	526	715.5	− 9.8	57	wsw.	7.2
8.21 a. m...	715.6	− 9.6	60	wsw.	7.6	1,042	669.2	−11.5	56	wnw.	15.7
8.34 a. m...	715.6	− 9.4	58	wsw.	6.7	1,454	634.0	−14.1	71	w.	28.8
8.43 a. m...	715.6	− 9.2	56	wsw.	6.3	1,262	650.2	−13.2	73	w.	24.1
8.53 a. m...	715.7	− 8.6	55	wsw.	7.6	526	715.7	− 8.6	55	wsw.	7.6
Second flight—											
9.02 a. m...	715.7	− 8.5	55	wsw.	6.3	526	715.7	− 8.5	55	wsw.	6.3
9.19 a. m...	715.7	− 8.0	62	wsw.	6.3	958	676.9	− 9.8	57	wnw.	16.7
9.32 a. m...	715.7	− 7.6	57	s.	3.1	1,644	619.1	−13.3	69	wnw.	36.6
9.34 a. m...	715.7	− 7.6	57	s.	3.1	1,749	610.6	−13.3	69	wnw.	36.6
9.41 a. m...	715.7	− 7.7	56	s.	4.0	2,108	582.7	− 8.5	70	w.	39.2
10.01 a. m...	715.7	− 7.5	56	s.	4.0	1,858	602.0	−14.0	76	wnw.	38.3
10.11 a. m...	715.7	− 7.4	55	s.	3.6	1,645	619.1	−13.1	79	wnw.	30.4
10.24 a. m...	715.6	− 7.0	56	ssw.	3.6	959	676.9	− 9.1	73	w.	14.7
10.32 a. m...	715.6	− 6.4	58	ssw.	4.5	526	715.6	− 6.4	58	ssw.	4.5

January 8, 1912.—Three kites were used; lifting surface, 16.0 sq. m. Wire out, 5,000 m., at maximum altitude.

There were 10/10 A-St., altitude, 3,000 m., from the southwest until about 9.20 a. m., after which there were 3/10 to 10/10 St., altitude, 950 m., from the south. Head kite entered the clouds at 9.06 a. m. and reappeared at 10.29 a. m.

High pressure (775 mm.) was central over New England. Pressure was low (753 mm.) over Arkansas.

January 9, 1912.—Two kites were used; lifting surface, 10.8 sq. m. Wire out, 2,500 m.; at maximum altitude, 2,400 m.

There were a few St. from the west-northwest.

A low (733 mm.) was central over Maine and a high (772 mm.) over the Texas coast.

January 10, 1912.—First flight: Two kites were used; lifting surface, 12.6 sq. m. Wire out, 1,500 m.; at maximum altitude, 1,400 m.

There were a few Ci.-St. from the west.

Second flight: Two kites were used; lifting surface, 10.7 sq. m. Wire out, 2,500 m. at maximum altitude.

There were a few Ci.-St. from the west.

Pressure was high (771 mm.) over Georgia and very low (744 mm.) over the Gulf of St. Lawrence.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Jan. 11, 1912:	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%		*m. p. s.*
8.08 a. m.	718.7	−10.4	93	ese.	6.3	526	718.7	−10.4	93	ese.	6.3
8.20 a. m.	718.8	−10.3	93	ese.	4.9	635	708.8	− 5.3	84	ssw.	7.4
9.02 a. m.	719.1	−10.4	91	ese.	4.5	842	690.6	− 6.2	80	wsw.	10.3
9.04 a. m.	719.1	−10.4	91	ese.	4.5	1,003	676.6	− 3.8	80	wsw.	10.3
9.24 a. m.	719.2	−10.0	80	ese.	5.4	1,611	626.2	− 8.2	95	w.	22.6
9.31 a. m.	719.2	−10.1	80	ese.	4.9	1,889	604.0	−10.1	100	w.	22.6
9.36 a. m.	719.2	−10.2	80	ese.	5.4	2,308	572.6	− 3.2	73	w.	29.4
9.54 a. m.	719.3	−10.0	74	e.	5.4	2,817	536.8	− 6.4	60	w.	27.4
10.30 a. m.	719.3	− 9.9	71	e.	6.3	3,078	519.3	− 6.2	44	w.	35.1
11.00 a. m.	719.3	−10.2	79	ese.	5.8	2,873	533.4	− 4.8	44	w.	26.2
11.27 a. m.	719.0	−10.1	76	e.	4.9	2,275	575.0	− 3.0	43	w.	20.1
11.40 a. m.	718.9	−10.2	79	ese.	4.9	2,044	591.9	− 3.7	66	w.	21.6
11.42 a. m.	718.9	−10.2	81	ese.	4.9	1,933	600.4	− 9.1	72	w.	23.5
12.00 m.	718.7	−10.3	84	ese.	4.9	1,179	661.2	− 5.1	89	sw.	11.8
12.05 p. m.	718.7	−10.2	70	ese.	5.4	837	690.6	− 5.9	82	ssw.	9.3
12.10 p. m.	718.6	−10.4	72	ese.	4.5	734	699.7	− 5.3	81	ssw.	9.1
12.14 p. m.	718.6	−10.3	70	ese.	4.9	526	718.6	−10.3	70	ese.	4.9
Jan. 12, 1912:											
4.14 p. m.	718.1	−13.4	100	nw.	9.8	526	718.1	−13.4	100	nw.	9.8
4.16 p. m.	718.1	−13.4	100	nw.	9.8	791	693.5	−14.5	100	nw.	14.1
4.30 p. m.	718.2	−13.4	100	nw.	12.5	1,239	654.1	− 8.3	94	wnw.	7.8
4.46 p. m.	718.2	−13.4	100	nw.	8.0	1,661	619.2	−13.5	100	wnw.	8.5
4.51 p. m.	718.3	−13.4	100	nw.	7.6	2,017	591.2	− 9.4	100	wnw.	17.2
4.54 p. m.	718.3	−13.4	100	nw.	7.6	2,146	581.5	− 9.9	100	wnw.	12.8
5.03 p. m.	718.3	−13.6	100	nw.	8.9	1,689	616.7	− 8.5	100	wnw.	7.1
5.19 p. m.	718.4	−13.6	100	nw.	8.9	1,355	644.1	−14.1	98	wnw.	20.3
5.25 p. m.	718.4	−13.8	100	nw.	8.9	1,033	671.8	−13.7	95	nw.	21.2
5.36 p. m.	718.4	−13.8	100	nw.	8.9	779	694.8	−15.2	95	nw.	16.6
5.39 p. m.	718.4	−13.8	100	nw.	8.9	526	718.4	−13.8	100	nw.	8.9
Jan. 13, 1912:											
8.26 a. m.	725.7	−22.4	72	wnw.	7.2	526	725.7	−22.4	72	wnw.	7.2
8.40 a. m.	725.9	−22.1	71	wnw.	8.5	955	684.9	−20.5	44	nne.	14.2
9.02 a. m.	726.2	−21.4	71	nw.	8.0	1,381	647.0	−18.3	29	nne.	11.2
9.22 a. m.	726.3	−21.0	70	nw.	5.8	1,798	612.4	−13.4	24	n.	9.6
10.03 a. m.	726.6	−20.6	70	nw.	7.2	2,655	547.6	−11.7	16	nnw.	18.7
10.30 a. m.	726.5	−20.2	72	wnw.	5.8	3,988	459.1	−19.5	15	wnw.	23.8
11.00 a. m.	726.4	−20.4	72	wnw.	6.7	3,163	512.7	−15.2	......	nw.	20.6
11.15 a. m.	726.2	−20.2	73	wnw.	8.5	2,610	551.2	−11.8	......	nnw.	17.2
11.28 a. m.	726.0	−20.1	73	wnw.	6.7	1,952	600.3	−11.1	......	nne.	9.2
11.35 a. m.	725.9	−19.8	73	wnw.	7.2	1,483	638.4	−15.3	......	nne.	9.8
11.51 a. m.	725.7	−19.4	73	wnw.	7.2	1,066	674.7	−18.8	......	ne.	9.1
11.57 a. m.	725.6	−19.5	73	wnw.	7.2	789	700.2	−21.7	......	n.	7.7
12.00 m.	725.6	−19.6	73	wnw.	7.2	526	725.6	−19.6	73	wnw.	7.2

January 11, 1912.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 7,000 m.; at maximum altitude, 6,350 m.

10/10 A-St., from the west, lowered from 1,900 m. to 1,700 m. Head kite entered the clouds at 9.30 a. m. and reappeared at 11.45 a. m.

Low pressure was central over Newfoundland (740 mm.), and northeastern Texas (756 mm.). High pressure (783 mm.), was central over North Dakota.

January 12, 1912.—Three kites were used; lifting surface, 19.4 sq. m. Wire out, 3,150 m.; at maximum altitude, 2,600 m.

There were 10/10 St. from the northwest; the head kite entered the clouds at 4.14 p. m. and emerged at 5.38 p. m.—altitude of clouds, 600 m. Light snow fell and the kites and wire were heavily coated with ice.

High pressure (784 mm.) was central over Kansas; low pressure was central off the Carolinas (759 mm.), over western Florida (760 mm.), and over Newfoundland (749 mm.).

January 13, 1912.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 5,000 m.; at maximum altitude, 4,800 m.

There were 2/10 to 7/10 Ci. from the west.

High pressure (778 mm.) was central over Pennsylvania and low pressure (762 mm.) over Florida.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind. Direction.	Wind. Velocity.	Height.	Pressure.	Temperature.	Rel. hum.	Wind. Direction.	Wind. Velocity.
Jan. 14, 1912:	mm.	C.	%		m. p. s.	m.	mm.	C.	%		m. p. s.
11.49 a. m.	721.6	−11.3	40	s.	7.2	526	721.6	−11.3	40	s.	7.2
11.55 a. m.	721.4	−11.5	41	s.	7.2	811	695.2	− 9.4	37	s.	16.2
12.02 p. m.	721.4	−11.6	41	ssw.	7.2	1,056	673.5	− 5.5	42	s.	16.2
12.10 p. m.	721.3	−10.0	41	s.	7.2	1,176	663.4	− 4.7	37	ssw.	16.5
12.15 p. m.	721.2	− 9.8	42	s.	5.8	1,585	629.8	− 5.2	33	ssw.	16.2
12.40 p. m.	720.9	−11.0	51	ssw.	4.5	2,146	586.0	− 7.4	25	ssw.	16.8
12.55 p. m.	720.7	−10.6	52	s.	3.6	2,436	564.4	− 7.4	22	ssw.	15.8
1.19 p. m.	720.2	− 8.8	39	se.	4.9	3,326	502.6	−12.2	21	ssw.	24.6
1.39 p. m.	719.7	− 9.8	25	se.	5.4	3,789	472.9	−14.6	20	sw.	26.1
2.07 p. m.	719.2	−10.2	53	w.	4.9	3,167	512.8	−10.8	20	sw.	23.5
2.21 p. m.	719.1	−11.1	64	w.	4.9	2,890	531.4	−11.2	20	sw.	19.4
2.42 p. m.	719.0	−13.2	66	sw.	4.5	2,194	581.2	− 6.3	22	sw.	16.0
2.55 p. m.	718.9	−12.3	52	ssw.	4.0	1,825	609.0	− 4.3	24	sw.	14.0
3.00 p. m.	718.9	−11.6	55	ssw.	4.0	1,702	618.7	− 3.4	24	ssw.	14.0
3.09 p. m.	718.9	−10.9	52	sw.	2.7	1,469	637.2	− 4.2	24	ssw.	13.2
3.14 p. m.	718.9	−10.3	53	s.	2.7	1,183	660.9	− 5.2	23	s.	15.7
3.18 p. m.	718.9	− 9.8	54	s.	4.5	1,093	668.5	− 7.7	24	s.	17.6
3.25 p. m.	718.9	−10.7	52	s.	4.9	1,005	676.1	− 7.9	64	s.	15.8
3.33 p. m.	718.8	−11.4	56	s.	5.8	600	712.0	− 6.3	87	s.	....
3.36 p. m.	718.8	−11.4	56	s.	5.8	526	718.8	−11.4	56	s.	5.8
Jan. 15, 1912:											
8.28 a. m.	709.1	− 7.6	71	sw.	6.3	526	709.1	− 7.6	71	sw.	6.3
8.37 a. m.	709.1	− 7.6	71	w.	6.3	694	694.1	− 3.7	71	wnw.	9.1
8.55 a. m.	709.0	− 9.3	72	wnw.	5.8	766	687.6	− 4.4	74	wnw.	12.7
9.00 a. m.	709.0	−10.0	74	wnw.	6.7	1,230	648.0	− 8.2	89	wnw.	13.7
9.13 a. m.	708.9	−10.6	70	wnw.	8.0	1,924	592.0	−12.9	91	w.	13.6
9.15 a. m.	708.9	−10.7	70	w.	8.0	1,956	589.6	−11.6	91	w.	13.6
9.38 a. m.	708.6	−10.0	73	w.	8.9	2,243	567.8	−11.2	91	w.	13.9
9.47 a. m.	708.5	−10.3	73	w.	8.9	2,737	532.1	−13.0	91	w.	17.3
10.47 a. m.	708.2	− 9.7	90	wnw.	12.5	4,072	444.4	−22.6	63	wsw.	24.8
11.07 a. m.	708.1	− 9.4	87	wnw.	12.5	3,563	475.2	−19.3	79	wsw.	20.6
11.15 a. m.	708.0	− 9.3	85	wnw.	13.4	2,915	517.9	−14.6	76	wsw.	20.6
12.38 p. m.	707.4	− 7.9	73	wnw.	13.9	2,436	551.0	−11.5	81	wsw.	17.9
12.58 p. m.	707.1	− 7.8	69	wnw.	12.5	1,912	589.6	−10.2	73	w.	....
1.03 p. m.	707.1	− 7.8	67	wnw.	11.2	1,586	615.4	−16.7	76	w.	....
1.15 p. m.	707.1	− 7.6	66	wnw.	12.1	1,421	629.1	−16.1	84	w.	....
1.26 p. m.	707.1	− 7.0	62	wnw.	11.6	874	676.0	−10.7	73	wnw.	....
1.38 p. m.	707.1	− 6.7	66	wnw.	11.6	526	707.1	− 6.7	66	wnw.	11.6
Jan. 16, 1912:											
2.21 p. m.	711.1	−11.6	63	wnw.	22.4	526	711.1	−11.6	63	wnw.	22.4
2.27 p. m.	711.1	−11.6	63	wnw.	20.6	922	674.9	−16.4	......	wnw.	24.5
2.34 p. m.	711.1	−11.6	63	wnw.	20.6	1,152	654.5	−17.8	......	wnw.	....
2.39 p. m.	711.1	−11.6	63	wnw.	23.2	526	711.1	−11.6	63	wnw.	23.2

January 14, 1912.—Four kites were used; lifting surface, 25.7 sq. m. Wire out, 6,000 m.; at maximum altitude, 5,800 m.

A.-St., from the west, decreased from 10/10 to 5/10; and after 3.02 p. m., St., from the south, increased from 2/10 to 5/10. The head kite entered the clouds, altitude, 900 m., at 3.02 p. m. and reappeared at 3.23 p. m. A solar halo was observed.

A ridge of high pressure (777 mm.) extended from Virginia to New Brunswick. Low pressure (763 mm.) was central over Lake Superior.

January 15, 1912.—Six kites were used; lifting surface, 38.3 sq. m. Wire out, 7,000 m.; at maximum altitude, 6,100 m.

Ci.-St. and A.-St., from the west, and St., from the west-northwest, varied from 8/10 to 10/10 until noon; after which there were 10/10 St. from the west-northwest. There was snow at intervals after 9.25 a. m. The head kite entered the clouds, altitude, 1,140 m., at 8.50 a. m. and reappeared at 10.30 a. m.

Low pressure was central southeast of Rhode Island (753 mm.) and over Lake Ontario (757 mm.). High pressure (780 mm.) was central over Minnesota.

January 16, 1912.—One kite was used; lifting surface, 5.4 sq. m. Wire out, 1,200 m., at maximum altitude.

There were a few St.-Cu. from the west-northwest.

Low pressure (744 mm.) was central over Maine and high pressure (773 mm.) over Tennessee.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Jan. 17, 1912:	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%		*m. p. s.*
8.17 a. m...	719.7	−12.0	62	ese.	7.2	526	719.7	−12.0	62	ese.	7.2
8.25 a. m...	719.7	−12.0	62	ese.	5.4	901	686.1	− 0.4	60	sw.	15.8
8.46 a. m...	719.7	−12.0	62	se.	7.6	1,350	648.7	0.7	58	sw.	18.8
8.53 a. m...	719.7	−12.0	62	se.	7.2	1,757	616.9	4.0	65	wsw.	25.2
9.03 a. m...	719.7	−11.5	60	se.	7.2	2,097	591.8	2.4	73	w.	23.9
9.38 a. m...	719.7	−11.0	57	se.	9.8	3,135	520.0	− 5.1	87	w.	35.2
10.20 a. m...	719.6	−11.0	59	se.	8.9	2,348	574.1	1.0	86	w.	25.9
10.45 a. m...	719.6	−10.3	60	se.	10.7	1,767	616.9	4.8	74	wsw.	24.8
10.55 a. m...	719.5	− 9.9	60	se.	10.3	1,380	646.9	4.7	76	sw.	22.0
11.09 a. m...	719.5	− 9.7	60	se.	9.8	902	686.1	2.4	71	sw.	15.1
11.16 a. m...	719.4	−10.0	60	se.	10.3	526	719.4	−10.0	60	se.	10.3
Jan. 18, 1912:											
8.04 a. m...	718.8	9.7	43	ssw.	7.2	526	718.8	9.7	43	ssw.	7.2
8.07 a. m...	718.8	9.6	43	ssw.	7.2	664	707.1	12.9	46	ssw.	10.8
8.13 a. m...	718.8	9.4	43	ssw.	6.3	960	682.6	12.1	43	ssw.	17.9
8.26 a. m...	718.8	8.0	49	s.	8.0	1,468	642.2	9.0	43	sw.	20.1
8.41 a. m...	718.7	9.4	43	s.	8.0	2,405	572.6	0.3	44	sw.	22.7
9.00 a. m...	718.7	10.4	43	ssw.	7.6	3,180	519.4	− 6.7	53	sw.	22.5
9.17 a. m...	718.7	10.6	41	s.	8.0	3,698	486.0	− 9.5	54	sw.	22.5
9.37 a. m...	718.6	10.2	40	ssw.	8.5	4,198	455.4	−12.4	54	sw.	23.7
9.44 a. m...	718.6	10.2	40	ssw.	8.0	4,332	447.5	−12.3	50	sw.	27.3
11.29 a. m...	717.9	7.0	46	ssw.	8.9	526	717.9	7.0	46	ssw.	8.9
Jan. 19, 1912:											
8.37 a. m...	709.2	4.6	82	wnw.	14.3	526	709.2	4.6	82	wnw.	14.3
8.48 a. m...	709.2	4.3	80	wnw.	14.8	920	675.6	1.7	79	wnw.	21.6
9.06 a. m...	709.3	3.5	78	wnw.	17.0	1,479	630.1	− 1.4	83	wnw.	23.7
9.08 a. m...	709.3	3.5	77	wnw.	17.0	1,540	625.3	0.5	78	w.	24.7
9.27 a. m...	709.7	2.7	75	wnw.	20.6	2,147	580.0	0.5	64	w.	23.7
9.47 a. m...	710.1	1.7	74	nw.	20.6	2,712	540.5	− 3.0	56	w.	33.5
10.28 a. m...	710.3	1.1	69	wnw.	25.0	1,888	599.3	1.3	43	wnw.	22.5
11.53 a. m...	710.3	0.1	68	nw.	27.7	1,888	599.3	3.3	23	wnw.	25.5
12.10 p. m..	710.4	− 0.1	67	nw.	24.1	1,888	599.3	− 0.4	23	wnw.	26.5
1.53 p. m...	711.0	− 0.4	66	nw.	16.1	1,888	599.3	− 1.6	23	wnw.	32.4
2.46 p. m...	711.8	− 0.6	60	nw.	13.4	526	711.8	− 0.6	60	nw.	13.4

January 17, 1912.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 4,000 m., at maximum altitude.

There were 10/10 to 9/10 A.-St. before 11 a. m. and 7/10 to 8/10 A.-St. and Ci.-St. thereafter, all moving from the west.

High pressure was central over the Carolina coast (773 mm.) and low pressure over eastern Newfoundland (743 mm.) and over Lake Superior (756 mm.).

January 18, 1912.—Five kites were used; lifting surface, 32.0 sq. m. Wire out, 7,000 m.; at maximum altitude, 6,600 m.

Ci.-St. and A.-St., from the west, varied from 9/10 to 10/10 until about 9.10 a. m.; after which there were 10/10 A.-St. from the west. A solar halo was observed at 8.41 a. m.

High pressure (775 mm.) was central over the Carolinas. Low pressure (757 mm.) was central over Michigan.

January 19, 1912.—Three kites were used; lifting surface, 16.0 sq. m. Wire out, 4,000 m.; at maximum altitude, 3,800 m.

There were 2/10 to a few A.-St. from the west before 9.20 a. m. and 7/10 to a few St.-Cu. from the west-southwest throughout.

Low pressure was central over Quebec (749 mm.) and high pressure over the lower Missouri Valley (773 mm.).

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Jan. 20, 1912:	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%		*m. p. s.*
1.04 p. m.	721.0	−6.2	80	sse.	7.2	526	721.0	− 6.2	80	sse.	7.2
1.12 p. m.	721.0	−6.2	80	sse.	7.2	757	699.9	− 8.9	70	ssw.	9.9
1.21 p. m.	720.9	−5.9	76	sse.	6.7	857	690.9	− 7.6	67	ssw.	9.4
1.46 p. m.	720.8	−5.7	72	se.	7.2	1,134	666.6	− 8.3	57	sw.	8.9
2.06 p. m.	720.8	−5.7	73	se.	6.7	1,434	641.5	− 6.1	43	sw.	9.8
2.25 p. m.	720.7	−5.5	75	se.	7.6	1,556	631.6	− 6.1	38	sw.	9.8
2.32 p. m.	720.6	−5.5	75	se.	8.0	2,308	573.1	−10.4	36	wsw.	14.2
2.36 p. m.	720.6	−5.5	75	se.	8.0	2,180	582.7	−10.6	36	wsw.	14.9
2.42 p. m.	720.6	−5.5	75	se.	7.6	2,649	548.1	−12.6	36	wsw.	20.1
3.00 p. m.	720.5	−5.6	75	sse.	7.2	3,308	502.5	−17.6	50	wsw.	25.5
3.02 p. m.	720.5	−5.6	75	se.	7.6	3,344	500.2	−17.6	51	wsw.	25.5
3.05 p. m.	720.5	−5.6	75	se.	7.6	3,308	502.5	−17.6	50	wsw.	25.5
3.16 p. m.	720.4	−5.3	72	se.	8.0	2,937	528.0	−14.8	46	wsw.	24.8
3.33 p. m.	720.3	−5.4	72	sse.	8.5	2,700	544.5	−14.6	43	wsw.	21.6
3.49 p. m.	720.3	−5.5	75	se.	7.6	1,883	605.7	− 8.5	40	wsw.	13.2
3.59 p. m.	720.2	−5.4	75	sse.	5.4	1,589	629.1	− 6.1	37	sw.	14.7
4.04 p. m.	720.2	−5.5	75	sse.	6.3	1,148	665.3	− 4.1	38	ssw.	10.5
4.10 p. m.	720.3	−5.5	75	sse.	6.7	955	681.9	− 5.6	51	ssw.	10.4
4.11 p. m.	720.3	−5.4	75	sse.	6.7	837	692.2	− 5.0	54	ssw.	10.4
4.13 p. m.	720.3	−5.3	76	sse.	6.7	750	699.9	− 7.3	56	s.	10.4
4.16 p. m.	720.3	−5.2	76	sse.	6.7	526	720.3	− 5.2	76	sse.	6.7
Jan. 21, 1912:											
8.39 a. m.	718.9	−3.8	68	w.	7.2	526	718.9	− 3.8	68	w.	7.2
8.50 a. m.	719.0	−4.2	68	w.	4.9	941	682.1	− 5.7	66	wnw.	14.7
9.05 a. m.	719.0	−4.2	66	wnw.	5.4	1,310	650.4	− 9.6	67	wnw.	19.4
9.10 a. m.	719.0	−4.0	67	w.	5.8	1,491	635.4	− 9.9	63	w.	23.8
9.12 a. m.	719.0	−3.9	68	w.	5.8	1,567	629.2	−10.9	56	w.	26.7
9.13 a. m.	719.0	−3.8	68	w.	5.8	1,705	618.1	− 9.6	51	w.	27.7
9.56 a. m.	719.2	−2.8	57	wnw.	2.2	2,519	556.4	−10.1	27	w.	24.9
10.33 a. m.	719.1	−2.0	55	w.	6.7	2,789	537.6	−10.3	22	w.	22.3
10.50 a. m.	719.1	−1.2	53	wnw.	5.8	2,248	576.8	− 7.2	20	w.	26.1
11.06 a. m.	719.1	−1.7	61	w.	5.8	1,739	615.6	− 6.8	20	w.	25.3
11.26 a. m.	719.1	−0.7	57	w.	8.0	1,433	640.4	−10.8	20	w.	16.0
11.33 a. m.	719.1	−0.4	55	w.	8.0	1,089	669.4	− 8.0	22	w.	13.4
11.42 a. m.	719.1	−0.4	55	w.	7.6	813	693.6	− 4.6	28	w.	8.3
11.47 a. m.	719.1	−0.4	55	w.	6.3	526	719.1	− 0.4	55	w.	6.3
Jan. 22, 1912:											
11.04 a. m.	718.6	5.1	37	s.	5.4	526	718.6	5.1	37	s.	5.4
11.17 a. m.	718.4	5.3	34	s.	6.3	894	686.5	1.6	37	ssw.	11.3
11.32 a. m.	718.2	5.1	36	s.	6.3	1,472	638.7	− 2.2	47	wsw.	24.4
11.35 a. m.	718.1	5.1	36	s.	4.9	1,689	621.3	− 1.5	47	w.	24.4
11.42 a. m.	718.0	5.2	36	s.	5.8	2,268	577.7	− 3.5	42	w.	20.6
11.52 a. m.	717.9	5.4	35	s.	4.9	2,905	532.6	− 5.6	45	w.	24.5
12.10 p. m.	717.7	5.3	36	s.	5.4	3,393	500.3	− 9.4	65	w.	24.5
12.33 p. m.	717.4	5.6	39	s.	5.4	2,852	536.3	− 5.5	59	w.	25.5
1.12 p. m.	717.0	6.8	38	s.	7.6	1,793	612.7	− 0.7	47	wsw.	23.3
1.14 p. m.	717.0	6.9	38	s.	7.6	1,585	628.8	− 1.4	47	wsw.	23.3
1.35 p. m.	716.7	7.2	40	s.	6.3	877	686.5	1.6	49	ssw.	12.2
1.43 p. m.	716.6	7.0	39	s.	7.2	526	716.6	7.0	39	s.	7.2

January 20, 1912.—Five kites were used; lifting surface, 32.0 sq. m. Wire out, 5,000 m.; at maximum altitude, 4,900 m.

There were 8/10 to 10/10 Ci.-St. and A.-St. from the west-southwest. Solar halo was visible until about 3.15 p. m. The head kite was in the base of the A.-St. at 3.02 p. m.; altitude, 3,300 m.

High pressure (772 mm.) was central over eastern Virginia and low pressure (756 mm.) over the Gulf of St. Lawrence.

January 21, 1912.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 5,000 m.; at maximum altitude, 4,600 m.

The sky was cloudless.

High pressure was central over northern Louisiana (775 mm.) and east of Nova Scotia (770 mm.) Pressure was low (760 mm.) over Lake Superior.

January 22, 1912.—Three kites were used; lifting surface, 19.4 sq. m. Wire out, 5,000 m.; at maximum altitude, 4,900 m.

There was 1/10 A.-Cu. from the west.

Low pressure (756 mm.) was central over the Gulf of St. Lawrence. High pressure (773 mm.) was central over Alabama.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind. Direction.	Wind. Velocity.	Height.	Pressure.	Temperature.	Rel. hum.	Wind. Direction.	Wind. Velocity.
Jan. 23, 1912:											
First flight—	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%		*m. p. s.*
8.03 a. m.	712.1	7.2	45	sw.	7.2	526	712.1	7.2	45	sw.	7.2
8.20 a. m.	712.0	7.0	46	sw.	5.4	1,301	647.4	1.9	49	w.	20.6
8.38 a. m.	712.0	6.8	48	sw.	5.4	1,870	602.8	− 4.3	78	w.	26.5
9.01 a. m.	711.9	7.4	45	sw.	6.7	1,348	643.6	0.8	68	w.	21.6
9.13 a. m.	711.9	7.4	45	sw.	7.6	975	674.0	4.4	61	w.	19.1
9.23 a. m.	711.9	7.6	45	sw.	7.6	526	711.9	7.6	45	sw.	7.6
Second flight—											
9.46 a. m.	711.8	8.3	43	sw.	10.7	526	711.8	8.3	43	sw.	10.7
10.11 a. m.	711.7	8.5	42	sw.	10.3	1,150	659.5	3.1	51	w.	17.6
10.26 a. m.	711.6	8.7	44	wsw.	11.2	1,796	608.2	− 3.8	74	w.	27.4
10.35 a. m.	711.6	8.8	44	wsw.	10.7	2,170	580.2	− 5.2	78	w.	24.5
10.42 a. m.	711.5	8.9	44	wsw.	11.6	2,218	576.6	− 3.9	69	w.	....
10.46 a. m.	711.5	9.0	44	wsw.	11.6	2,234	575.4	− 5.7	71	w.	28.4
11.07 a. m.	711.4	9.2	42	wsw.	10.3	2,723	540.7	− 5.0	39	w.	29.4
11.38 a. m.	711.1	9.4	42	w.	11.2	2,346	566.9	− 7.1	41	w.	35.5
11.45 a. m.	711.1	9.1	44	w.	11.6	2,313	569.3	− 4.7	53	w.	35.3
12.09 p. m.	710.9	9.6	46	wnw.	11.6	1,839	604.5	− 3.6	74	wnw.	....
12.29 p. m.	710.7	9.8	44	wnw.	13.9	1,123	660.8	3.1	66	wnw.	....
12.47 p. m.	710.5	9.7	44	wnw.	18.8	526	710.5	9.7	44	wnw.	18.8
Jan. 24, 1912:											
8.04 a. m.	710.2	1.2	72	wnw.	11.2	526	710.2	1.2	72	wnw.	11.2
8.15 a. m.	710.2	1.2	70	wnw.	13.4	898	677.9	− 2.5	89	wnw.	15.3
8.40 a. m.	710.3	1.1	70	wnw.	12.5	1,567	622.6	− 8.5	97	w.	13.2
9.06 a. m.	710.3	0.9	74	wnw.	13.4	1,975	590.6	−11.7	99	w.	....
9.27 a. m.	710.4	0.7	70	wnw.	14.3	2,286	566.7	−13.0	100	w.	....
10.12 a. m.	710.5	0.4	71	wnw.	14.3	1,106	660.1	− 6.5	100	wnw.	....
10.35 a. m.	710.6	0.6	72	wnw.	14.3	841	683.0	− 5.1	99	nw.	....
10.49 a. m.	710.7	0.6	72	wnw.	14.3	738	692.0	− 3.2	88	nw.	....
10.57 a. m.	710.7	0.9	66	wnw.	13.9	526	710.7	0.9	66	wnw.	13.9
Jan. 26, 1912:											
10.21 a. m.	709.1	−8.2	100	se.	11.6	526	709.1	− 8.2	100	se.	11.6
10.25 a. m.	709.0	−8.2	100	se.	11.6	818	682.8	− 9.2	98	sse.	15.2
10.34 a. m.	709.0	−8.2	100	se.	11.6	934	672.6	− 7.2	98	s.	19.9
10.35 a. m.	709.0	−8.2	100	se.	11.6	1,191	651.0	− 3.4	97	ssw.	19.9
10.42 a. m.	708.9	−8.2	100	se.	11.6	1,611	617.2	− 5.2	98	ssw.	17.3
10.46 a. m.	708.8	−8.2	100	se.	11.6	1,865	597.5	− 4.3	99	sw.	20.2
10.54 a. m.	708.8	−8.2	100	se.	10.3	2,226	570.8	− 6.1	100	sw.	22.7
11.08 a. m.	708.6	−8.2	100	se.	10.7	1,607	617.2	− 3.2	100	ssw.	24.0
11.11 a. m.	708.6	−8.2	100	se.	11.2	1,435	630.8	− 4.5	100	ssw.	19.2
11.13 a. m.	708.6	−8.2	100	se.	11.2	1,248	645.9	− 4.0	100	s.	19.2
11.16 a. m.	708.5	−8.2	100	se.	10.7	960	669.8	− 7.2	100	s.	17.6
11.25 a. m.	708.4	−8.0	100	se.	9.4	767	686.7	− 9.4	99	sse.	15.8
11.27 a. m	708.4	−8.0	100	se.	9.4	526	708.4	− 8.0	100	se.	9.4

January 23, 1912.—First flight: Two kites were used; lifting surface, 12.6 sq. m. Wire out, 2,000 m., at maximum altitude.

There were 3/10 to 4/10 Ci.-Cu. and St.-Cu., all from the west.

Second flight: Three kites were used; lifting surface, 16.1 sq. m. Wire out, 5,000 m., at maximum altitude.

There were 1/10 to 4/10 Ci.-Cu. and St.-Cu., all from the west, altitude of St.-Cu. less than 2,300 m.

Low pressure was central over New York (755 mm.) and high pressure over the Gulf States (768 mm.).

January 24, 1912.—Four kites were used; lifting surface, 22.4 sq. m. Wire out, 5,000 m.; at maximum altitude, 4,600 m.

St. from the west, altitude 1,200 m., and St.-Cu. from the west, altitude 2,000 m., varied from 10/10 to 5/10 before 10.30 a. m. Thereafter, there were 3/10 St.-Cu. The head kite entered the clouds at 8.30 and reappeared about 10.30 a. m.

Low pressure (742 mm.) was central over Newfoundland. High pressure was central over Iowa (768 mm.) and north of Lake Superior (767 mm.).

January 26, 1912.—Two kites were used; lifting surface, 12.6 sq. m. Wire out, 2,500 m.; at maximum altitude, 2,400 m.

There were dense fog and heavy snow.

High pressure (763 mm.) was central over New York and New England; low pressure (752 mm.) was central over western Iowa.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Jan. 27, 1912:											
First flight—	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%		*m. p. s.*
10.19 a. m...	709.0	−8.1	100	w.	7.6	526	709.0	− 8.1	100	w.	7.6
10.31 a. m...	709.1	−7.8	100	w.	7.6	927	673.7	− 6.7	94	nnw.	22.5
10.37 a. m...	709.2	−7.7	100	wnw.	7.6	664	696.8	− 4.5	83	nnw.	21.4
10.42 a. m...	709.2	−7.5	100	wnw.	8.0	1,457	629.5	− 8.7	87	nw.	28.7
10.58 a. m...	709.4	....	......	wnw.	8.0	622	700.7	− 4.4	74	nnw.	26.6
11.10 a. m...	709.4	....	......	wnw.	7.6	930	673.7	− 6.7	82	n.	20.8
11.26 a. m...	709.4	....	......	wnw.	8.0	526	709.4	....	......	wnw.	8.0
Second flight—											
1.24 p. m...	709.8	−4.2	86	wnw.	7.6	526	709.8	− 4.2	86	wnw.	7.6
1.32 p. m...	709.9	−4.4	83	wnw.	8.9	984	669.5	− 8.1	71	nw.	16.7
1.38 p. m...	709.9	−4.2	77	wnw.	9.4	1,528	624.0	−12.9	76	nw.	23.5
1.47 p. m...	710.0	−4.0	80	wnw.	10.3	1,774	604.2	−13.6	90	nw.	23.1
1.50 p. m...	710.0	−3.8	77	nw.	10.7	2,010	585.9	− 9.7	53	nw.	....
2.19 p. m...	710.4	−3.1	68	wnw.	11.6	2,142	576.2	− 9.0	22	nw.	....
2.44 p. m...	710.8	−3.0	57	wnw.	15.2	2,904	522.5	−10.0	10	wnw.	....
3.05 p. m...	711.0	−2.9	57	wnw.	13.4	526	711.0	− 2.9	57	wnw.	13.4
Jan. 28, 1912:											
2.50 p. m...	718.3	−8.6	70	se.	13.0	526	718.3	− 8.6	70	se.	13.0
2.53 p. m...	718.3	−8.6	70	se.	13.0	727	699.8	−10.0	69	s.	20.4
2.59 p. m...	718.2	−8.6	70	se.	11.6	1,037	672.6	− 1.7	63	s.	21.2
3.04 p. m...	718.2	−8.5	67	se.	13.4	1,120	665.7	− 0.1	61	ssw.	17.5
3.16 p. m...	718.2	−8.3	64	se.	12.5	1,641	623.6	− 3.3	83	sw.	18.4
3.22 p. m...	718.2	−8.0	60	se.	13.0	1,890	604.5	4.4	47	sw.	19.7
3.38 p. m...	718.1	−8.2	64	se.	12.5	2,583	555.0	1.4	77	sw.	23.9
3.53 p. m...	718.1	−8.0	67	se.	11.6	3,302	507.2	− 3.9	78	wsw.	29.3
4.12 p. m...	718.1	−8.0	65	se.	13.4	2,587	555.0	0.1	96	sw.	26.5
4.26 p. m...	718.1	−8.0	65	se.	12.5	1,954	600.0	4.4	77	sw.	22.1
4.33 p. m...	718.0	−8.1	70	se.	12.1	1,761	614.4	5.7	79	sw.	27.2
4.38 p. m...	718.0	−8.2	72	se.	13.9	1,471	636.8	− 3.6	97	sw.	20.8
4.46 p. m...	718.0	−8.0	65	se.	13.0	1,284	652.0	− 2.6	85	sw.	22.1
4.49 p. m...	718.0	−8.0	65	se.	13.4	1,118	665.7	− 0.7	83	s.	20.7
4.57 p. m...	718.0	−7.8	77	se.	13.4	886	685.6	− 5.2	75	sse.	20.2
5.01 p. m...	718.0	−7.9	77	se.	12.5	658	705.9	− 9.4	74	se.	19.0
5.04 p. m...	718.0	−8.0	77	se.	12.5	526	718.0	− 8.0	77	se.	12.5

January 27, 1912.—First flight: Two kites were used; lifting surface 12.6 sq. m. Wire out, 2,000 m., at maximum altitude.

There was dense fog, becoming light at intervals, until 10.40 a. m. Thereafter, St. from the west-northwest decreased from 10/10 to 8/10. The head kite came out of the St., altitude a few meters above station.

Second flight: Two kites were used; lifting surface 12.6 sq. m. Wire out, 5,000 m., at maximum altitude.

St.-Cu. from the northwest increased from 4/10 to 6/10 before 1.50 p. m. Thereafter, they decreased to a few by 2.30 p. m. The head kite was momentarily in passing St.-Cu., altitude 1,770 m., at 1.49 p. m.

Pressure was low east of the middle Atlantic coast (754 mm.), and over southern Virginia (755 mm.). High pressure (768 mm.) was central over Minnesota.

January 28, 1912.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 4,300 m.; at maximum altitude, 3,900 m.

There were 10/10 A. St. from the west until 3.37 p. m., after 3.37 p. m., 9/10 to 10/10 St.-Cu. from the southwest until 4.41 p. m., and after 4.41 p. m. 10/10 St. from the southwest. Light snow fell after 4.55 p. m. The head kite entered St.-Cu. at 3.37 p. m., altitude about 2,500 m.; emerged from St. at 4.37 p. m., altitude about 1,500 m.

Low pressure (755 mm.) was central over Missouri. High pressure (771 mm.) was central over Maryland.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Jan. 30, 1912:	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%		*m. p. s.*
8.29 a. m....	708.5	−1.9	92	wnw.	17.9	526	708.5	− 1.9	92	wnw.	17.9
8.36 a. m....	708.6	−2.0	94	wnw.	20.6	853	679.9	− 4.4	91	nw.	30.4
8.46 a. m....	708.7	−2.0	92	wnw.	22.4	1,112	657.8	− 6.0	92	nw.	26.0
9.04 a. m....	708.9	−2.1	92	wnw.	17.0	1,555	622.8	6.2	41	w.	18.0
9.13 a. m ...	708.9	−2.1	94	wnw.	18.3	2,088	583.3	0.6	41	w.	19.4
9.44 a. m....	708.9	−2.2	92	wnw.	18.8	2,721	538.3	− 3.0	29	w.	28.7
10.00 a. m....	708.9	−2.1	92	wnw.	19.9	2,134	578.9	0.9	27	w.	19.9
10.15 a. m....	708.9	−2.0	90	wnw.	13.4	1,639	615.4	3.6	37	w.	19.3
10.25 a. m....	708.9	−2.1	91	wnw.	13.9	1,349	638.2	− 8.7	66	nw.	22.6
10.36 a. m....	708.9	−2.2	92	wnw.	14.3	937	672.8	− 6.2	97	nw.	23.4
10.47 a. m....	708.9	−2.2	92	wnw.	14.8	833	681.9	− 5.7	95	nw.	20.7
10.53 a. m....	708.9	−2.3	92	wnw.	15.6	526	708.9	− 2.3	92	wnw.	15.6
Jan. 31, 1912:											
8.10 a. m...	707.7	−6.9	70	wnw.	13.0	526	707.7	− 6.9	70	wnw.	13.0
8.19 a. m...	707.5	−6.8	67	wnw.	13.4	907	673.5	−10.7	75	wnw.	22.1
8.28 a. m...	707.4	−6.8	67	wnw.	14.3	1,243	644.5	−14.1	80	wnw.	27.6
8.41 a. m...	707.2	−6.9	67	wnw.	17.0	1,747	602.6	−16.6	77	wnw.	30.4
8.50 a. m...	707.1	−6.9	67	wnw.	17.4	2,002	582.6	−14.2	73	wnw.	23.8
9.42 a. m...	706.9	−6.8	72	wnw.	15.2	2,618	536.6	−19.0	74	wnw.	11.0
9.58 a. m...	706.9	−6.6	72	wnw.	16.1	2,960	512.4	−23.3	84	wnw.	11.5
10.32 a. m...	706.9	−6.2	69	wnw.	15.6	2,673	532.4	−20.1	78	wnw.	12.3
10.41 a. m...	706.9	−6.1	66	wnw.	16.1	2,326	557.7	−17.1	77	wnw.	16.9
11.03 a. m...	706.9	−5.7	64	wnw.	16.1	1,642	611.0	−17.1	78	wnw.	22.7
11.28 a. m...	706.9	−5.6	64	wnw.	16.5	1,239	644.5	−13.9	89	wnw.	21.2
11.40 a. m...	706.8	−5.6	64	wnw.	16.5	912	672.5	−10.5	79	wnw.	20.2
11.53 a. m...	706.8	−5.6	66	wnw.	15.6	526	706.8	− 5.6	66	wnw.	15.6
Feb. 1, 1912:											
7.52 a. m...	711.6	−5.5	72	wnw.	6.3	526	711.6	− 5.5	72	wnw.	6.3
8.06 a. m...	711.6	−5.5	72	wnw.	8.5	817	685.6	− 7.8	70	wnw.	14.2
8.26 a. m...	711.6	−5.5	71	wnw.	7.2	1,379	637.4	−12.9	82	wnw.	20.3
9.06 a. m...	711.6	−4.6	69	wnw.	5.8	1,626	617.5	− 7.3	56	wnw.	22.0
9.25 a. m...	711.5	−4.6	69	wnw.	7.6	2,625	542.6	−11.3	24	wnw.	15.7
11.07 a. m...	710.7	−3.3	67	wsw.	5.8	2,225	571.2	−10.9	37	wnw.	15.7
11.23 a. m...	710.6	−3.0	61	w.	4.0	1,407	634.9	− 7.5	53	wnw.	19.5
11.28 a. m...	710.6	−3.0	61	wsw.	4.0	1,255	647.4	− 8.9	60	w.	14.2
11.40 a. m...	710.5	−2.8	61	wsw.	6.3	526	710.5	− 2.8	61	wsw.	6.3

January 30, 1912.—Four kites were used; lifting surface, 21.5 sq. m. Wire out, 4,400 m.; at maximum altitude, 4,000 m.

St. from the northwest, covered the sky, except about 9 a. m. when 1/10 A.-Cu. from the west-northwest were visible. The head kite entered the St., altitude 1,000 m., at 8.40 a. m. and reappeared at 10.31 a. m.

Low pressure (739 mm.) was central over Newfoundland. High pressure (770 mm.) was central over South Dakota.

January 31, 1912.—Four kites were used; lifting surface, 21.4 sq. m. Wire out, 5,600 m., at maximum altitude.

There were 2/10 to 7/10 A.-Cu. from the west-northwest and after 11 a. m., 4/10 to 6/10 St.-Cu. from the same direction; altitude of St.-Cu., 1,550 m.

Low pressure was central east of Massachusetts (750 mm.) and high pressure over Louisiana (770 mm.).

February 1, 1912.—Four kites were used; lifting surface, 24.3 sq. m. Wire out, 5,000 m.; at maximum altitude, 3,400 m.

St.-Cu., from the west-northwest, decreased from 6/10 to none by 9.45 a. m. Head kite entered the clouds at 8.55 a. m.; altitude, 1,600 m. Ci.-St., from the west, appeared about 9 a. m. and covered the sky after 10.45 a. m. A solar halo was observed.

Low pressure (742 mm.) was central over the Gulf of St. Lawrence, with a secondary depression (755 mm.) over northern Indiana.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Feb. 2, 1912:	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%		*m. p. s.*
8.03 a. m...	706.1	− 4.6	71	wnw.	12.1	526	706.1	− 4.6	71	wnw.	12.1
8.12 a. m...	706.2	− 4.8	74	wnw.	12.1	862	676.5	− 7.7	71	wnw.	15.2
8.24 a. m...	706.3	− 4.8	71	wnw.	13.0	1,236	644.7	−10.7	70	wnw.	14.7
9.27 a. m...	706.4	− 5.1	64	wnw.	17.9	1,990	584.1	−14.5	62	wnw.	7.8
10.07 a. m...	706.4	− 4.6	67	wnw.	16.1	1,326	637.2	−10.5	59	wnw.	19.0
10.19 a. m...	706.5	− 4.5	69	wnw.	15.6	880	675.2	− 9.0	68	wnw.	17.6
10.31 a. m...	706.5	− 4.6	60	wnw.	16.1	526	706.5	− 4.6	60	wnw.	16.1
Feb. 3, 1912:											
8.02 a. m...	713.2	−13.0	71	nw.	8.5	526	713.2	−13.0	71	nw.	8.5
8.12 a. m...	713.3	−13.1	71	nw.	8.5	889	680.0	−14.6	74	w.	14.7
8.21 a. m...	713.4	−13.0	71	nw.	9.4	1,312	643.4	−12.2	58	wnw.	17.7
8.30 a. m...	713.4	−12.9	71	nw.	9.4	1.521	626.0	−12.5	57	wnw.	16.0
8.50 a. m...	713.6	−12.7	67	nw.	8.9	2,397	558.0	−15.5	57	w.	20.5
9.07 a. m...	713.7	−12.3	67	nw.	8.0	3,394	488.2	−21.8	57	w.	26.3
9.34 a. m...	713.8	−12.0	69	wnw.	5.4	2,398	558.0	−16.5	57	w,	18.3
9.50 a. m...	713.8	−11.8	69	wnw.	5.4	1,544	624.7	−12.7	57	w.	11.2
9.57 a. m...	713.8	−11.6	68	wnw.	4.5	1,334	642.1	−11.8	55	w.	12.5
10.05 a. m...	713.8	−11.4	66	w.	3.1	968	673.6	−13.8	50	wsw.	13.7
10.14 a. m...	713.8	−11.2	64	w.	3.6	526	713.8	−11.2	64	w.	3.6
Feb. 4, 1912:											
4.19 p. m...	713.6	−11.8	48	wnw.	21.5	526	713.6	−11.8	48	wnw.	21.5
4.28 p. m...	713.6	−12.1	47	wnw.	19.7	946	675.2	−16.3	39	wnw.	32.3
4.37 p. m...	713.6	−12.0	43	nw.	19.7	1,452	631.2	−17.8	28	wnw.	24.5
4.40 p. m...	713.6	−12.1	44	nw.	18.8	1.525	625.1	−19.2	24	nw.	32.0
4.43 p. m...	713.6	−12.2	46	nw.	17.9	1,703	610.3	−16.2	21	nw.	....
4.52 p. m...	713.6	−12.2	46	nw.	16.1	1,856	598.1	−18.2	17	nw.	....
5.02 p. m...	713.6	−12.2	46	nw.	15.2	1,496	627.5	−13.2	11	nw.	....
5.13 p. m...	713.7	−12.4	45	nw.	15.6	1,275	646.2	−18.2	10	nw.	21.6
5.28 p. m...	713.9	−12.6	45	nw.	11.6	920	677.7	−17.0	15	wnw.	17.6
5.35 p. m...	714.0	−13.0	27	nw.	9.4	526	714.0	−13.0	27	nw.	9.4
Feb. 5, 1912:											
1.15 p. m...	714.4	−13.1	63	wnw.	13.4	526	714.4	−13.1	63	wnw.	13.4
1.25 p. m...	714.3	−12.9	63	wnw.	11.6	851	684.4	−17.2	61	wnw.	10.3
1.35 p. m...	714.2	−12.8	60	wnw.	13.4	1,274	646.4	−19.0	63	wnw.	17.2
1.37 p. m...	714.2	−12.8	60	wnw.	13.4	1,303	643.9	−14.6	68	wnw.	18.9
2.11 p. m...	714.1	−12.6	60	wnw.	14.3	1,588	620.3	−12.5	68	wnw.	10.6
3.00 p. m...	713.9	−11.8	62	wnw.	15.2	2,097	580.2	−12.9	72	wnw.	8.2
3.30 p. m...	713.8	−11.3	63	wnw.	15.6	1.702	610.8	−11.0	66	wnw.	11.5
3.43 p. m...	713.8	−11.3	63	wnw.	15.2	1,302	643.9	−19.2	73	wnw.	....
4.00 p. m...	713.8	−11.4	63	wnw.	15.2	875	681.8	−15.9	70	wnw.	....
4.07 p. m...	713.8	−11.8	66	wnw.	14.8	526	713.8	−11.8	66	wnw.	14.8

February 2, 1912.—Five kites were used; lifting surface, 30.6 sq. m. Wire out, 5,000 m.; at maximum altitude, 3,700 m.

A few Ci. and Ci.-Cu. from the west, 1/10 to 5/10 A.-Cu. from the west-northwest and 3/10 to 9/10 St.-Cu. from the west-southwest covered from 4/10 to 10/10 of the sky.

Low pressure (745 mm.) was central over Nova Scotia. High pressure (770 mm.) was central over Minnesota.

February 3, 1912.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 4,000 m.; at maximum altitude, 3,800 m.

There were 9/10 to 6/10 Ci.-Cu. and Ci.-St. from the west. A halo was observed.

High pressure was central over Florida (767 mm.) and low pressure over Missouri (754 mm.) and over Nova Scotia (747 mm.).

February 4, 1912.—One kite was used; lifting surface, 5.4 sq. m. Wire out, 2,500 m.; at maximum altitude, 2,300 m.

The sky was cloudless.

Low pressure (747 mm.) was central over the Gulf of St. Lawrence. High pressure (780 mm.) was central over Kansas.

February 5, 1912.—Five kites were used; lifting surface, 29.6 sq. m. Wire out, 5,500 m.; at maximum altitude, 3,900 m.

During the flight A.-St. from the west decreased from 9/10 to none. After 2.50 p. m. there were a few A.-Cu. from the west.

Low pressure (739 mm.) was central over Newfoundland. High pressure (777 mm.) was central over the Dakotas.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Feb. 6, 1912:	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%		*m. p. s.*
10.00 a. m...	715.5	−12.0	69	wnw.	17.0	526	715.5	−12.0	69	wnw.	17.0
10.06 a. m...	715.5	−11.9	69	wnw.	16.1	939	677.7	−16.3	59	wnw.	21.6
10.22 a. m...	715.4	−11.5	62	wnw.	18.8	1,365	641.0	− 7.4	59	nnw.	11.7
10.25 a. m...	715.4	−11.3	58	wnw.	17.9	1,581	623.6	− 7.6	59	nnw.	11.7
10.40 a. m...	715.3	−11.3	66	wnw.	17.9	2,000	590.5	−11.3	59	nnw.	9.3
10.48 a. m...	715.3	−11.2	66	wnw.	17.9	2,514	552.0	−15.1	61	nnw.	8.7
11.17 a. m...	715.2	−11.0	64	wnw.	16.1	2,660	541.5	−13.0	63	nnw.	17.2
11.22 a. m...	715.2	−11.0	64	wnw.	16.1	3,465	486.8	−18.3	60	nnw.	21.6
11.25 a. m...	715.2	−10.8	62	wnw.	16.1	3,663	474.2	−17.4	60	nw.	19.0
11.35 a. m...	715.1	−10.6	58	wnw.	17.9	3,770	467.3	−19.1	51	nw.	18.8
11.45 a. m...	715.1	−10.2	54	wnw.	16.1	3,639	475.4	−17.5	51	nw.	17.4
11.47 a. m...	715.1	−10.2	54	wnw.	16.1	3,479	485.7	−18.2	51	nw.	15.7
12.04 p. m..	715.1	−10.0	59	wnw.	16.1	2,657	541.5	−12.2	51	nnw.	18.6
12.17 p. m..	715.0	− 9.7	60	wnw.	18.8	2,425	558.1	−15.9	60	nnw.	9.5
12.32 p. m..	715.0	− 9.5	61	wnw.	17.0	2,139	579.7	−13.7	68	nnw.	10.8
12.46 p. m..	714.9	− 9.1	59	nw.	16.1	1,336	643.5	− 7.7	68	nnw.	9.3
12.53 p. m..	714.9	− 9.0	58	wnw.	13.4	1,213	653.6	− 7.4	64	nw.	15.9
1.02 p. m..	714.9	− 8.8	56	wnw.	15.2	1,037	668.8	−14.3	69	wnw.	16.6
1.11 p. m..	714.9	− 8.8	56	wnw.	14.3	526	714.9	− 8.8	56	wnw.	14.3
Feb. 8, 1912:											
First flight—											
8.13 a. m...	711.7	− 5.6	70	w.	6.7	526	711.7	− 5.6	70	w.	6.7
8.27 a. m...	711.8	− 5.2	66	w.	7.6	968	672.6	− 8.7	86	w.	11.8
8.39 a. m...	711.8	− 4.9	66	w.	8.0	1,293	644.8	−12.2	93	w.	15.2
8.53 a. m...	711.9	− 4.6	65	w.	7.2	1,904	595.1	−16.2	98	w.	....
9.10 a. m...	712.0	− 4.7	69	w.	7.6	2,090	580.6	−14.8	43	w.	....
9.21 a. m...	712.0	− 4.7	71	w.	6.7	2,333	562.3	−15.6	36	w.	....
9.23 a. m...	712.1	− 4.8	72	w.	6.7	2,481	551.2	−14.9	35	w.	....
9.26 a. m...	712.1	− 4.9	73	w.	6.7	2,429	554.8	−15.2	33	w.	....
10.54 a. m...	712.0	− 4.3	60	w.	6.3	1,884	596.3	−18.3	52	w.	....
11.07 a. m...	712.0	− 3.6	56	w.	13.9	1,391	636.8	−13.4	61	w.	....
11.20 a. m...	712.0	− 3.8	55	w.	13.9	971	672.6	− 9.2	69	w.	17.1
11.28 a. m...	712.0	− 3.8	59	wnw.	14.8	526	712.0	− 3.8	59	wnw.	14.8
Second flight—											
12.18 p. m..	711.4	− 3.4	39	wnw.	13.0	526	711.4	− 3.4	39	wnw.	13.0
12.28 p. m..	711.3	− 3.4	39	nw.	15.6	950	673.8	− 8.8	42	w.	19.3
12.37 p. m..	711.2	− 3.6	42	nw.	15.2	1,249	648.0	−11.3	41	w.	24.2
12.50 p. m..	711.1	− 3.2	43	wnw.	15.2	1,898	594.8	−17.6	40	w.	25.5
1.09 p. m..	711.0	− 3.4	43	wnw.	16.1	2,259	566.8	−18.1	23	w.	32.8
1.29 p. m..	711.0	− 3.2	42	wnw.	15.6	2,544	545.8	−14.3	12	w.	35.2
1.50 p. m..	711.0	− 3.4	44	wnw.	16.5	2,832	525.3	−16.6	9	w.	34.3
1.57 p. m..	711.0	− 3.2	46	wnw.	16.5	3,115	505.9	−16.0	9	w.	37.4
2.02 p. m..	711.0	− 3.1	46	wnw.	15.6	2,869	522.8	−16.9	7	w.	36.3
2.51 p. m..	711.3	− 2.8	40	wnw.	12.5	2,328	561.8	−14.6	4	w.	30.2
3.15 p. m..	711.4	− 2.8	38	wnw.	12.5	2,120	577.8	−18.6	5	w.	22.6
3.20 p. m..	711.4	− 2.7	39	wnw.	12.1	1,902	594.8	−18.2	7	w.	17.7
3.28 p. m..	711.4	− 2.7	39	wnw.	13.9	1,436	632.8	−13.6	11	w.	14.5
3.39 p. m..	711.5	− 2.8	41	wnw.	14.3	1,181	654.2	−11.3	18	w.	16.2
3.49 p. m..	711.5	− 2.8	31	wnw.	11.2	907	677.8	− 7.6	23	w.	16.7
3.55 p. m..	711.6	− 2.8	33	wnw.	13.0	526	711.6	− 2.8	33	wnw.	13.0

February 6, 1912.—Six kites were used; lifting surface, 37.8 sq. m. Wire out, 5,600 m.; at maximum altitude, 4,900 m.

There were a few A.-Cu. from the west after 10.50 a. m.

Low pressure was central over Nova Scotia (754 mm.) and south of Florida (760 mm.). High pressure was central over Oklahoma (773 mm.).

February 8, 1912.—*First flight:* Three kites were used; lifting surface, 18.9 sq. m. Wire out, 5,000 m.; at maximum altitude, 3,500 m.

St.-Cu., from the west, diminished 10/10 at 8.15 to few at 11.30 a. m. Head kite entered the clouds at 8.52 a. m.; altitude, 1,600 m. Light snow fell from 8.36 to 8.41 and 8.50 to 9.49 a. m. There was a heavy snow storm at about 1,000 m. altitude from 8.21 to 8.52 a. m.

At 8 a. m. high pressure (772 mm.) was central over North Dakota and low pressure (753 mm.) over the middle St. Lawrence valley.

Second flight: Four kites were used; lifting surface, 25.2 sq. m. Wire out, 7,000 m. at maximum altitude, 6,900 m.

The sky was cloudless.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Feb. 8, 1912—Con.											
Third flight—	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%		*m. p. s.*
4.32 p. m.	711.8	−3.0	36	wnw.	11.6	526	711.8	− 3.0	36	wnw.	11.6
4.44 p. m.	711.8	−3.0	30	wnw.	13.4	879	680.6	− 7.2	36	w.	16.7
4.59 p. m.	711.9	−3.4	30	wnw.	10.7	1,155	656.9	− 9.9	36	w.	17.2
5.13 p. m.	712.0	−3.6	30	wnw.	8.9	1,698	611.8	−16.1	36	w.	17.6
5.27 p. m.	712.1	−4.1	36	wnw.	8.9	2,048	584.1	−19.7	36	wnw.	15.5
5.33 p. m.	712.2	−4.2	38	wnw.	8.0	2,532	547.3	−18.0	36	wnw.	34.3
5.45 p. m.	712.4	−4.6	39	wnw.	7.2	2,890	521.8	−18.2	32	wnw.	34.3
6.00 p. m.	712.5	−4.9	41	wnw.	5.4	2,337	562.0	−16.8	17	wnw.	32.5
6.06 p. m.	712.5	−5.0	45	wnw.	5.4	2,048	584.1	−17.9	17	wnw.	29.4
6.16 p. m.	712.5	−5.3	36	wnw.	6.7	1,454	631.9	−14.0	18	wnw.	20.3
6.32 p. m.	712.6	−5.3	35	wnw.	10.7	1,203	653.1	−11.6	20	wnw.	22.0
6.55 p. m.	712.6	−5.6	31	wnw.	14.3	853	683.4	− 8.4	21	wnw.	21.6
7.09 p. m.	712.6	−6.0	36	wnw.	13.0	526	712.6	− 6.0	36	wnw.	13.0
Fourth flight—											
7.44 p. m.	712.6	−6.2	33	wnw.	13.4	526	712.6	− 6.2	33	wnw.	13.4
8.07 p. m.	712.6	−6.6	34	wnw.	13.9	1,029	667.8	−10.1	26	wnw.	19.6
8.23 p. m.	712.7	−6.8	27	wnw.	11.6	1,537	625.1	−14.4	25	wnw.	23.5
8.42 p. m.	712.7	−6.7	24	wnw.	8.5	2,113	579.5	−13.0	24	wnw.	28.3
9.02 p. m.	712.8	−7.1	30	wnw.	8.9	2,407	557.5	−12.5	21	wnw.	25.4
9.10 p. m.	712.8	−7.3	33	wnw.	11.2	3,013	514.8	−15.0	18	wnw.	31.3
9.20 p. m.	712.8	−7.6	37	wnw.	12.1	3,446	486.0	−17.0	14	wnw.	33.8
9.32 p. m.	712.9	−7.7	36	wnw.	13.0	3,537	480.1	−17.5	11	wnw.	34.6
9.47 p. m.	712.9	−8.0	35	wnw.	8.5	3,281	496.7	−17.4	10	wnw.	31.6
10.12 p. m.	713.0	−8.8	34	wnw.	8.9	2,557	546.4	−13.0	10	wnw.	27.9
10.27 p. m.	713.1	−8.6	33	wnw.	5.4	2,206	572.2	−10.8	10	wnw.	26.9
10.46 p. m.	713.2	−8.2	33	wnw.	6.3	1,726	609.6	−16.3	9	wnw.	25.2
10.58 p. m.	713.3	−8.4	33	wnw.	7.6	1,330	642.4	−14.2	9	wnw.	18.6
11.11 p. m.	713.3	−8.8	33	wnw.	7.2	1,003	670.4	−11.1	10	wnw.	15.2
11.26 p. m.	713.3	−8.8	34	wnw.	6.3	526	713.3	− 8.8	34	wnw.	6.3
Feb. 9, 1912:											
10.25 a. m.	711.6	−6.7	37	s.	5.4	526	711.6	− 6.7	37	s.	5.4
10.40 a. m.	711.5	−6.4	41	s.	4.5	856	681.9	− 9.9	37	wsw.	8.3
11.12 a. m.	711.2	−5.4	45	s.	3.6	1,239	648.4	−12.8	36	wsw.	17.1
11.17 a. m.	711.2	−5.6	45	s.	3.1	1,619	616.8	−15.0	34	wsw.	20.6
11.19 a. m.	711.2	−5.5	45	s.	3.1	1,694	610.8	−14.1	33	w.	27.9
11.21 a. m.	711.2	−5.4	45	s.	3.1	1,723	608.4	−16.7	29	w.	27.9
11.22 a. m.	711.2	−5.4	45	s.	3.1	1,783	603.5	−14.2	28	w.	31.6
11.28 a. m.	711.2	−5.2	46	s.	3.1	2,078	580.6	−12.8	25	wnw.	34.5
11.33 a. m.	711.1	−5.0	47	s.	3.1	2,320	562.3	−13.0	23	wnw.	36.0
11.45 a. m.	711.1	−5.1	50	s.	2.2	526	711.1	− 5.1	50	s.	2.2

Third flight.—Three kites were used; lifting surface, 18.0 sq. m. Wire out, 5,400 m.; at maximum altitude, 5,000 m.

The sky was cloudless.

Fourth flight.—Four kites were used; lifting surface, 23.4 sq. m. Wire out, 5,500 m.; at maximum altitude, 5,100 m.

The sky was cloudless.

At 8 p. m. high pressure (768 mm.) was central over South Dakota and low pressure (751 mm.) over New Brunswick.

February 9, 1912.—Two kites were used; lifting surface, 13.1 sq. m. Wire out, 2,700 m., at maximum altitude.

There were a few A.-Cu. from the west.

Low pressure (747 mm.) was central over New Brunswick and high pressure (770 mm.) over Minnesota and North Dakota.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Feb. 10, 1912:	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%		*m. p. s.*
8.17 a. m...	715.1	−17.0	72	nw.	8.9	526	715.1	−17.0	72	nw.	8.9
8.39 a. m...	715.4	−16.8	72	nw.	13.4	996	671.5	−21.5	78	nw.	15.6
8.47 a. m...	715.4	−16.8	72	wnw.	10.3	1,558	623.4	− 9.3	65	nw.	24.9
8.55 a. m...	715.5	−16.8	72	nw.	7.6	1,895	597.0	−10.8	59	nw.	24.8
9.10 a. m...	715.6	−17.0	78	nw.	8.0	2,144	578.3	− 7.6	51	nw.	24.1
9.22 a. m...	715.6	−17.2	78	nw.	9.8	2,753	534.5	− 9.2	49	nw.	27.6
9.36 a. m...	715.7	−17.2	78	nw.	8.9	3,241	501.7	−10.4	48	nw.	32.2
9.55 a. m...	715.7	−17.0	78	nw.	6.7	2,687	539.0	− 9.2	49	nw.	26.5
10.12 a. m...	715.7	−16.8	72	nw.	5.4	2,259	569.5	− 6.6	45	nw.	24.8
10.28 a. m...	715.8	−16.3	70	nw.	5.8	1,801	604.2	−11.2	43	nw.	23.0
10.35 a. m...	715.8	−16.2	70	nw.	4.5	1,576	622.4	−10.8	45	nw.	23.5
10.44 a. m...	715.8	−16.2	70	nw.	5.4	1,334	642.3	−15.2	45	nw.	23.0
10.50 a. m...	715.9	−16.1	70	nw.	5.4	1,003	671.5	−21.6	44	nw.	23.1
10.55 a. m...	715.9	−16.0	70	nw.	5.4	526	715.9	−16.0	70	nw.	5.4
Feb. 11, 1912:											
9.26 a. m...	712.3	−16.2	80	nw.	6.3	526	712.3	−16.2	80	nw.	6.3
9.34 a. m...	712.2	−16.3	77	nw.	6.3	669	698.9	−14.8	62	nnw.	9.0
9.44 a. m...	712.2	−16.4	74	nw.	7.6	792	687.7	− 9.3	48	n.	8.1
10.49 a. m...	712.0	−14.8	62	nw.	9.8	526	712.0	−14.8	62	nw.	9.8
Feb. 13, 1912:											
8.20 a. m...	723.2	−11.6	85	nw.	9.4	526	723.2	−11.6	85	nw.	9.4
9.41 a. m...	723.9	−10.4	87	nw.	11.6	1,471	641.4	− 8.2	42	n.	10.1
9.47 a. m...	723.9	−10.4	83	nw.	11.2	1,123	670.5	− 5.0	41	nnw.	9.8
9.53 a. m...	724.0	−10.4	87	nw.	10.3	837	695.5	− 6.3	49	nnw.	14.7
10.00 a. m...	724.0	− 9.9	77	nw.	10.7	526	724.0	− 9.9	77	nw.	10.7
Feb. 14, 1912:											
8.13 a. m...	722.9	− 7.2	54	sse.	5.8	526	722.9	− 7.2	54	sse.	5.8
8.17 a. m...	722.9	− 7.1	54	sse.	5.8	937	686.0	− 3.2	37	sw.	20.7
8.38 a. m...	723.0	− 7.2	55	sse.	6.3	1,219	662.2	− 3.8	19	sw.	17.4
8.55 a. m...	723.0	− 6.6	50	sse.	6.3	1,477	641.0	− 2.5	33	wsw.	13.3
9.46 a. m...	722.8	− 5.6	47	sse.	5.8	2,100	592.5	− 4.4	15	wsw.	14.7
10.07 a. m...	722.7	− 5.0	50	sse.	4.9	2,396	570.4	− 7.2	16	wsw.	18.0
10.15 a. m...	722.7	− 4.8	50	sse.	5.4	2,026	597.9	− 4.6	15	w.	13.0
10.33 a. m...	722.6	− 4.9	55	sse.	5.8	1,546	635.4	− 3.5	41	w.	11.4
10.49 a. m...	722.5	− 4.6	58	sse.	7.2	1,123	670.1	− 2.4	53	sw.	14.3
10.55 a. m...	722.5	− 4.8	58	sse.	6.7	925	687.0	− 1.7	44	sw.	12.0
11.04 a. m...	722.5	− 4.9	60	sse.	7.2	526	722.5	− 4.9	60	sse.	7.2

February 10, 1912.—Four kites were used; lifting surface, 24.3 sq. m. Wire out, 5,000 m., at maximum altitude.

There were 3/10 to a few Ci.-St. from the west. A halo was observed.

High pressure was central over Ohio (769 mm.) and low pressure over Southern Alabama.

February 11, 1912.—Four kites were used; lifting surface, 27.2 sq. m. Wire out, 2,000 m.; at maximum altitude, 600 m.

There were 7/10 to 5/10 Ci.-St. from the west.

High pressure (766 mm.) was central north of the lower lakes and low pressure (754 mm.) off the Carolina coast.

February 13, 1912.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 2,600 m.; at maximum altitude, 1,200 m.

The sky was cloudless.

Low pressure (745 mm.) was central over Newfoundland. High pressure (777 mm.) was central over Lake Huron.

February 14, 1912.—Three kites were used; lifting surface 18.9 sq. m. Wire out, 3,300 m.; at maximum altitude, 2,600 m.

There were 10/10 Ci.-St. from the west. A solar halo was observed after 8.38 a. m.

Low pressure was central over western Florida (756 mm.) and over Newfoundland (754 mm.). Pressure was high (774 mm.) over the Middle Atlantic States.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Feb. 15, 1912:	*mm.*	° *C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%		*m. p. s.*
8.08 a. m.	717.2	−5.2	56	e.	6.7	526	717.2	−5.2	56	e.	6.7
8.15 a. m.	717.2	−5.1	57	e.	6.3	864	687.2	−1.8	58	e.	10.3
8.20 a. m.	717.2	−5.0	54	e.	5.4	970	678.2	−2.0	59	e.	10.3
8.36 a. m.	717.1	−4.8	57	ne.	4.9	1,118	665.5	−1.9	58	e.	8.8
9.44 a. m.	717.0	−3.7	56	ene.	5.4	1,149	662.9	0.1	48	e.	7.7
10.10 a. m.	717.0	−2.8	50	ene.	2.7	1,523	632.8	−0.7	44	e.	5.0
10.41 a. m.	716.9	−2.8	57	ene.	2.7	968	678.2	−1.4	56	e.	10.8
10.51 a. m.	716.9	−2.6	49	ene.	4.0	526	716.9	−2.6	49	ene.	4.0
Feb. 16, 1912:											
8.52 a. m.	710.4	−5.5	75	nw.	12.1	526	710.4	−5.5	75	nw.	12.1
9.00 a. m.	710.4	−5.4	75	nw.	13.4	919	675.8	−2.5	59	nw.	17.5
11.05 a. m.	710.6	−1.6	62	nw.	13.9	1,656	617.1	−2.2	39	nnw.	6.8
11.22 a. m.	710.6	−1.2	64	nw.	12.5	1,035	666.7	2.8	43	nw.	9.8
11.35 a. m.	710.6	−0.8	63	nw.	12.5	772	689.0	−3.3	62	nw.	13.3
11.41 a. m.	710.6	−0.4	62	nw.	12.5	526	710.6	−0.4	62	nw.	12.5
Feb. 18, 1912:											
11.02 a. m.	709.7	1.4	89	e.	5.4	526	709.7	1.4	89	e.	5.4
11.05 a. m.	709.7	1.4	89	e.	5.4	603	702.9	0.7	93	e.	11.0
11.10 a. m.	709.7	1.4	89	e.	5.4	872	679.9	3.2	88	ese.	11.3
11.31 a. m.	709.6	1.6	90	e.	4.5	1,531	626.3	−1.6	93	ese.	10.3
12.20 p. m.	709.6	2.0	86	e.	3.6	1,758	608.5	−3.9	100	se.	7.6
12.54 p. m.	709.5	2.4	83	e.	3.6	1,511	627.5	−2.3	100	ese.	7.9
1.15 p. m.	709.5	2.2	83	e.	3.6	997	669.2	0.1	97	ese.	12.8
1.22 p. m.	709.5	2.2	83	e.	3.6	526	709.5	2.2	83	e.	3.6
Feb. 19, 1912:											
11.16 a. m.	715.2	5.9	78	ssw.	5.8	526	715.2	5.9	78	ssw.	5.8
11.22 a. m.	715.2	6.4	75	s.	4.9	684	701.6	6.1	68	sw.	7.5
11.30 a. m.	715.2	6.8	72	s.	4.5	909	682.7	5.1	68	sw.	8.1
12.15 p. m.	715.0	7.7	69	ssw.	1.8	1,210	657.8	4.4	64	sw.	8.4
12.24 p. m.	714.9	7.8	68	s.	1.8	825	689.4	6.0	65	sw.	7.0
12.30 p. m.	714.8	8.0	68	s.	1.8	526	714.8	8.0	68	s.	1.8

February 15, 1912.—Five kites were used; lifting surface, 32.0 sq. m. Wire out, 3,450 m.; at maximum altitude, 2,600 m.

There were 3/10 Ci.-St. and 7/10 A.-St., from the west, until about 9 a. m., and thereafter 10/10 A.-St. from the west.

Low pressure (752 mm.) was central over the coast of South Carolina. High pressure (770 mm.) was central over New England.

February 16, 1912.—Six kites were used; lifting surface, 38.3 sq. m. Wire out, 5,000 m.; at maximum altitude, 3,200 m.

There was light haze and after 10 a. m. a few A.-St. from the west.

Low pressure was central off the Middle Atlantic coast (754 mm.) and high pressure over Nova Scotia (767 mm.) and over Florida (764 mm.).

February 18, 1912.—Three kites were used; lifting surface, 23.8 sq. m. Wire out, 3,700 m.; at maximum altitude, 3,000 m.

There were 10/10 St.-Cu. from the south and a few St. from the southeast at the beginning. The St. had increased to 10/10 by 12.30 p. m. Light rain fell from 11.46 a. m. until 11.55 a. m. The head kite was in St. at intervals from 11.27 a. m. until 1.05 p. m.; altitude varied from about 1,000 m. to about 800 m.

Low pressure (748 mm.) was central north of Lake Superior; a secondary low (754 mm.) was central over the North Carolina coast. High pressure (765 mm.) was central over Maine.

February 19, 1912.—Two kites were used; lifting surface, 13.1 sq. m. Wire out, 1,100 m.; at maximum altitude, 900 m.

Ci-St. from the west, increased from 5/10 to 8/10. A solar halo was visible after 11.40 a. m.

High pressure (765 mm.) was central over the Florida Peninsula. Low pressure was central north of Lake Huron (745 mm.) and east of the North and Middle Atlantic coast (758 mm.).

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind. Direction.	Wind. Velocity.	Height.	Pressure.	Temperature.	Rel. hum.	Wind. Direction.	Wind. Velocity.
Feb. 20, 1912:	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%		*m. p. s.*
8.03 a. m....	714.4	3.8	85	nw.	9.8	526	714.4	3.8	85	nw.	9.8
8.11 a. m....	714.4	3.7	86	nw.	9.8	959	677.2	1.6	90	wnw.	15.7
8.17 a. m....	714.5	3.8	85	nw.	8.5	1,238	654.2	1.1	89	wnw.	16.2
8.42 a. m....	714.5	4.1	87	nw.	9.8	1,530	631.0	2.4	70	wnw.	9.6
9.20 a. m....	714.6	4.5	81	nw.	13.4	1,922	600.9	−2.5	68	w.	8.3
9.55 a. m....	714.5	4.1	87	nw.	12.5	2,349	569.2	−2.5	43	w.	11.0
10.21 a. m...	714.6	4.2	85	nw.	8.9	2,143	584.0	−3.8	44	w.	7.6
10.38 a. m...	714.9	4.3	82	nw.	10.7	1,951	598.5	−2.2	46	w.	8.8
11.01 a. m...	715.1	4.2	82	nw.	8.9	1,444	638.0	0.4	42	wnw.	10.8
11.08 a. m...	715.2	4.2	82	nw.	8.9	1,199	657.8	−1.6	73	wnw.	14.0
11.17 a. m...	715.2	4.2	82	nw.	8.0	953	678.5	0.1	81	wnw.	14.7
11.26 a. m...	715.3	4.2	82	nw.	8.5	526	715.3	4.2	82	nw.	8.5
Feb. 22, 1912:											
3.44 p. m...	708.5	−2.8	48	wnw.	20.6	526	708.5	− 2.8	48	wnw.	20.6
3.50 p. m...	708.6	−2.7	46	wnw.	24.1	866	678.6	− 7.7	50	wnw.	26.5
4.04 p. m...	708.9	−2.8	41	wnw.	19.7	1,170	652.7	−10.8	59	wnw.	27.4
4.16 p. m...	709.1	−2.6	41	wnw.	17.9	1,755	604.3	−17.2	71	wnw.	30.4
4.35 p. m...	709.4	−2.6	38	wnw.	17.9	2,130	575.3	−18.8	51	wnw.	34.5
5.03 p. m...	709.8	−2.8	41	wnw.	21.5	1,615	616.7	−16.4	66	wnw.	30.5
5.25 p. m...	709.9	−2.9	42	w.	20.6	1,183	652.7	−10.4	69	wnw.	25.5
5.40 p. m...	709.9	−3.2	44	w.	20.6	881	678.6	− 7.2	61	wnw.	27.4
5.48 p. m...	709.8	−3.2	48	w.	22.4	526	709.8	− 3.2	48	w.	22.4
Feb. 23, 1912:											
4.04 p. m...	720.7	3.1	56	sse.	4.5	526	720.7	3.1	56	sse.	4.5
4.51 p. m...	720.9	2.3	42	sse.	4.9	1,007	679.0	−1.6	48	s.	6.9
5.14 p. m...	720.9	2.2	46	sse.	5.4	1,195	663.2	−3.1	47	ssw.	8.3
5.23 p. m...	721.0	2.0	39	s.	5.4	1,952	602.4	−5.9	46	w.	14.7
5.49 p. m...	721.1	1.8	41	s.	6.3	2,799	540.2	−9.8	53	w.	21.6
6.23 p. m...	721.2	1.4	40	sse.	5.8	1,999	588.7	−6.7	51	w.	17.1
6.39 p. m...	721.3	1.4	40	sse.	6.7	1,331	652.0	−4.1	48	sw.	9.2
6.44 p. m...	721.3	1.3	43	sse.	7.2	1,041	676.3	−1.8	48	sw.	8.8
6.57 p. m...	721.4	1.1	39	s.	6.7	526	721.4	1.1	39	s.	6.7

February 20, 1912.—Six kites were used; lifting surface, 38.3 sq. m. Wire out, 6,100 m.; at maximum altitude, 5,400 m.

There were 10/10 A.-St. from the west and a few St. from the west-northwest. The head kite was in St. from 11.04 a. m. until 11.08 a. m.; altitude about 1,200 m.

Low pressure was central over Texas (751 mm.) and over Quebec (754 mm.). High pressure (776 mm.) central over Yellowstone Park, extended over the Great Lakes. Pressure was moderately high off the South Atlantic coast.

February 22, 1912.—Two kites were used; lifting surface, 10.7 sq. m. Wire out, 3,500 m., at maximum altitude, 3,300 m.

There were a few St.-Cu. from the west-northwest, altitude, 1,700 m.

Low pressure was central over Vermont (727 mm.) and high pressure over Louisiana (768 mm.).

February 23, 1912.—Three kites were used; lifting surface, 21.9 sq. m. Wire out, 3,500 m., at maximum altitude.

The sky was cloudless.

High pressure (771 mm.) was central over the Carolinas. Low pressure (748 mm.) was central over Nova Scotia.

54365—12——4

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Feb. 24, 1912:	mm.	C.	%		m. p. s.	m.	mm.	C.	%		m. p. s.
11.36 a. m.	721.0	2.2	43	sse.	5.4	526	721.0	2.2	43	sse.	5.4
11.48 a. m.	720.9	2.2	47	sse.	6.3	1,152	667.4	4.6	33	s.	12.1
12.00 m.	720.8	2.2	52	se.	6.3	1,611	630.6	2.4	32	ssw.	12.2
12.15 p. m.	720.6	2.3	51	se.	4.9	2,167	588.4	−2.4	32	ssw.	11.8
12.30 p. m.	720.4	2.0	59	se.	7.6	2,519	562.6	−0.8	29	ssw.	18.1
12.55 p. m.	720.1	2.2	52	se.	5.8	3,405	503.3	−3.8	27	sw.	22.7
1.24 p. m.	719.8	2.4	52	se.	8.0	2,613	555.9	−1.0	33	sw.	18.6
1.30 p. m.	719.8	2.2	54	se.	8.9	2,407	570.6	−1.6	31	sw.	19.6
1.54 p. m.	719.6	2.5	51	se.	9.4	1,500	638.6	2.2	23	ssw.	17.2
2.09 p. m.	719.4	2.4	53	se.	8.9	947	683.2	6.2	17	s.	16.0
2.15 p. m.	719.4	2.4	53	se.	8.9	526	719.4	2.4	53	se.	8.9
Feb. 25, 1912:											
8.21 a. m.	717.4	3.1	84	wnw.	13.4	526	717.4	3.1	84	wnw.	13.4
8.33 a. m.	717.5	3.2	84	wnw.	10.3	975	678.8	1.5	56	nw.	14.7
8.52 a. m.	717.6	3.8	80	wnw.	10.3	1,516	635.1	3.1	70	nw.	16.8
8.55 a. m.	717.6	3.8	79	wnw.	9.8	1,796	613.5	0.3	96	nw.	19.2
8.57 a. m.	717.6	3.8	81	wnw.	10.7	1,889	606.3	3.1	82	nw.	18.3
9.24 a. m.	717.5	4.6	75	wnw.	11.2	2,568	557.4	0.1	62	wnw.	13.2
10.01 a. m.	717.4	5.1	65	wnw.	12.5	3,404	501.7	−4.5	45	wnw.	24.5
10.02 a. m.	717.4	5.1	65	wnw.	12.5	3,589	490.1	−4.1	42	wnw.	24.5
10.38 a. m.	717.5	5.8	63	wnw.	10.7	4,025	463.5	−9.2	24	wnw.	28.4
11.09 a. m.	717.5	6.5	63	wnw.	11.2	3,591	490.1	−5.1	21	wnw.	22.5
11.10 a. m.	717.5	6.4	63	wnw.	11.2	3,557	492.4	−5.3	21	wnw.	24.5
11.31 a. m.	717.3	6.8	59	wnw.	10.3	2,818	540.4	−2.1	18	nw.	21.6
11.56 a. m.	717.1	6.7	55	wnw.	8.9	1,606	627.9	5.0	41	nw.	11.3
12.05 p. m.	717.1	7.1	55	wnw.	7.2	1,545	632.7	2.1	68	nw.	16.9
12.10 p. m.	717.0	7.4	55	wnw.	7.4	1,339	648.9	3.5	74	nw.	14.5
12.12 p. m.	717.0	7.3	54	wnw.	8.0	1,163	663.2	2.6	74	nw.	14.7
12.23 p. m.	717.0	7.4	55	wnw.	8.0	833	690.7	4.1	61	nw.	11.0
12.28 p. m.	717.0	7.3	50	wnw.	8.0	526	717.0	7.3	50	wnw.	8.0
Feb. 26, 1912:											
2.58 p. m.	704.5	2.0	100	se.	14.3	526	704.5	2.0	100	se.	14.3
3.02 p. m.	704.5	2.0	100	se.	13.4	818	679.4	0.7	100	s.	26.7
3.06 p. m.	704.4	2.0	100	se.	13.4	930	669.8	2.3	100	s.	23.3
3.11 p. m.	704.3	2.0	100	se.	13.4	1,489	625.8	9.9	86	s.	18.1
3.22 p. m.	704.1	2.0	100	se.	15.2	1,918	594.0	7.3	100	s.	....
5.05 p. m.	701.8	1.8	100	se.	14.8	526	701.8	1.8	100	se.	14.8

February 24, 1912.—Four kites were used; lifting surface, 27.2 sq. m. Wire out, 4,500 m.; at maximum altitude, 4,300 m.

There were 10/10 Ci.-St. from the west and a few St.-Cu. from the south at the beginning. The St.-Cu. had disappeared by 12.30 p. m. A solar halo was observed.

High pressure (773 mm.) central over the coast of Virginia, covered the eastern United States.

February 25, 1912.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 6,500 m. at maximum altitude.

10/10 St. Cu. from the northwest had decreased to none at the end. As the St. Cu. dissipated, Ci. St. from the west-northwest appeared, increasing to 9/10 at the end. A solar halo was observed. The head kite entered St. Cu. at 8.55 a. m., altitude about 1,800 m.; was visible after 9.06 a. m.

High pressure (777 mm.) was central over Manitoba. Low pressure (744 mm.) was central over Newfoundland; also over Texas (752 mm.).

February 26, 1912.—Two kites were used; lifting surface, 11.7 sq. m. Wire out, 1,800 m.; at maximum altitude, 1,700 m.

There was dense fog and light rain fell.

Low pressure (745 mm.) was central over Illinois. High pressure (768 mm.) was central over Vermont.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Feb. 27, 1912:	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%		*m. p. s.*
8.52 a. m....	703.2	−2.8	82	wnw.	22.4	526	703.2	− 2.8	82	wnw.	22.4
8.57 a. m....	703.2	−2.8	82	wnw.	21.5	915	669.2	− 7.2	86	wnw.	27.5
9.10 a. m....	703.2	−2.6	78	wnw.	22.4	1,297	637.1	−10.8	94	wnw.	27.5
9.15 a. m....	703.2	−2.6	77	wnw.	22.4	1,612	611.5	−12.9	95	wnw.	30.3
9.26 a. m....	703.3	−2.4	75	wnw.	23.2	1,905	588.7	− 5.8	53	wnw.	40.1
9.32 a. m....	703.3	−2.4	75	wnw.	23.2	2,304	559.5	− 5.7	41	wnw.	38.1
9.43 a. m....	703.3	−2.6	74	wnw.	22.4	2,583	539.9	− 7.0	33	nw.	39.0
10.25 a. m...	703.4	−2.3	79	wnw.	23.2	1,890	589.9	− 4.9	35	wnw.	....
10.38 a. m...	703.5	−2.2	79	wnw.	22.4	1,659	607.9	−12.4	45	wnw.	....
10.42 a. m...	703.5	−2.2	79	wnw.	21.5	526	703.5	− 2.2	79	wnw.	21.5
Feb. 28, 1912:											
8.05 a. m...	713.7	−4.0	68	wnw.	7.2	526	713.7	− 4.0	68	wnw.	7.2
8.16 a. m...	713.8	−3.4	69	wnw.	7.2	999	672.1	− 6.8	62	w.	14.2
8.20 a. m...	713.8	−3.3	67	wnw.	7.2	1,136	660.4	− 7.3	61	w.	20.8
8.30 a. m...	713.8	−2.8	66	wnw.	6.7	1,551	626.4	− 4.9	50	wnw.	18.0
8.43 a. m...	713.8	−2.2	59	wnw.	6.7	1,891	599.9	− 5.9	48	wnw.	17.2
9.14 a. m...	713.9	−2.0	67	wnw.	6.7	2,395	562.7	− 7.1	33	w.	18.4
9.48 a. m...	713.9	−1.6	63	w.	6.7	3,114	512.4	−14.7	46	w.	23.9
10.25 a. m...	713.8	−0.5	66	w.	7.6	2,270	571.7	− 8.1	45	wnw.	23.2
10.46 a. m...	713.7	−0.1	64	w.	6.7	1,764	609.9	− 5.5	58	wnw.	23.0
11.05 a. m...	713.7	0.3	61	wsw.	6.7	1,440	635.7	− 4.9	59	w.	18.4
11.10 a. m...	713.7	0.5	62	wsw.	6.3	1,337	644.1	− 7.6	59	w.	15.3
11.23 a. m...	713.7	1.8	68	wsw.	6.7	901	681.0	− 3.3	58	wsw.	10.6
11.31 a. m...	713.7	1.0	72	wsw.	5.4	526	713.7	1.0	72	wsw.	5.4
Feb. 29, 1912:											
8.00 a. m...	718.9	−4.6	76	nnw.	5.8	526	718.9	−4.6	76	nnw.	5.8
8.13 a. m...	719.0	−4.4	77	nnw.	5.4	818	692.8	−6.5	87	nw.	7.6
8.37 a. m...	719.2	−4.0	72	nnw.	3.1	989	678.0	−7.6	91	wnw.	6.6
9.03 a. m...	719.4	−3.4	70	nnw.	2.7	1,112	667.5	−8.3	89	wnw.	9.3
9.09 a. m...	719.4	−3.4	73	n.	2.7	526	719.4	−3.4	73	n.	2.7
Mar. 1, 1912:											
First flight—											
8.19 a. m....	721.7	−7.8	82	wnw.	11.2	526	721.7	− 7.8	82	wnw.	11.2
8.33 a. m....	721.9	−8.0	85	wnw.	10.3	1,034	675.7	−13.6	85	nw.	13.3
9.05 a. m....	722.2	−7.6	66	wnw.	9.4	1,298	652.9	−15.2	91	wnw.	9.8
9.17 a. m....	722.2	−7.6	66	wnw.	9.8	1,845	606.9	−19.3	81	wnw.	19.1
9.19 a. m....	722.2	−7.6	66	wnw.	9.8	1,969	597.0	−17.0	69	wnw.	22.6
9.21 a. m....	722.2	−7.6	66	wnw.	10.3	2,039	591.5	−17.8	60	wnw.	25.9
9.24 a. m....	722.2	−7.5	66	wnw.	10.3	2,085	587.9	−15.0	50	wnw.	23.5
9.37 a. m....	722.1	−7.4	66	nw.	9.8	2,429	561.6	−14.9	43	wnw.	24.2
9.50 a. m....	722.1	−7.2	66	nw.	10.7	2,926	525.8	−16.7	36	wnw.	28.0
9.51 a. m....	722.1	−7.2	67	wnw.	10.7	2,979	522.2	−15.6	34	wnw.	28.8
9.59 a. m....	722.1	−7.0	67	wnw.	10.7	3,030	518.7	−17.8	34	wnw.	28.8
10.00 a. m...	722.1	−7.0	67	wnw.	10.7	3,081	515.2	−16.6	33	wnw.	28.5
10.07 a. m...	722.1	−7.0	66	wnw.	10.7	3,170	509.1	−19.0	31	wnw.	30.0
10.09 a. m...	722.1	−7.0	66	wnw.	11.6	3,257	503.1	−16.9	29	wnw.	30.4
10.12 a. m...	722.1	−6.8	65	wnw.	11.6	3,312	499.7	−16.9	28	wnw.	29.6
10.26 a. m...	722.2	−6.4	66	wnw.	10.3	2,954	524.1	−14.6	23	wnw.	28.1

February 27, 1912.—Two kites were used; lifting surface, 10.7 sq. m. Wire out, 4,500 m., at maximum altitude.

There were 7/10 to 10/10 St. Cu. from the west-northwest. The head kite entered the clouds at 9.14 a. m., altitude, 1,600 m.

Lows were central over New York (743 mm.) and east of Massachusetts (740 mm.). A high was central over Texas (769 mm.).

February 28, 1912.—Four kites were used; lifting surface, 25.7 sq. m. Wire out, 5,500 m., at maximum altitude.

There were a few A.-Cu. from the west-northwest between 9.10 and 11.10 a. m.

Low pressure (744 mm.) was central over Nova Scotia. High pressure was central over Alabama (767 mm.) and over Alberta (777 mm.).

February 29, 1912.—Two kites were used; lifting surface, 13.1 sq. m. Wire out, 1,000 m.; at maximum altitude, 700 m.

6/10 A.-St. from the west had increased to 9/10 by 9 a. m.

High pressure (777 mm.), central over the Missouri Valley, covered nearly the entire United States. Low pressure (747 mm.) was central over Newfoundland.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Mar. 1, 1912—Con.											
***First flight*—Con.**	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%		*m. p. s.*
10.31 a. m.	722.2	−6.4	67	wnw.	9.8	2,677	543.7	−15.8	23	wnw.	27.3
10.36 a. m.	722.2	−6.3	68	wnw.	8.0	2,554	552.7	−14.9	24	wnw.	26.1
10.50 a. m.	722.3	−6.8	62	wnw.	7.2	2,456	559.9	−19.5	29	wnw.	28.6
11.05 a. m.	722.3	−6.5	63	wnw.	9.8	2,278	573.3	−15.0	35	wnw.	25.5
11.10 a. m.	722.3	−6.3	64	wnw.	9.4	2,021	593.3	−16.6	35	wnw.	24.7
11.12 a. m.	722.3	−6.2	64	wnw.	7.6	1,849	606.9	−15.7	35	wnw.	23.2
11.20 a. m.	722.2	−6.2	64	wnw.	8.5	1,771	613.3	−19.4	41	wnw.	17.5
11.28 a. m.	722.2	−5.4	62	wnw.	7.6	1,499	636.1	−17.5	56	wnw.	14.0
11.48 a. m.	722.1	−5.4	56	wnw.	10.7	974	681.6	−11.0	68	wnw.	10.8
11.56 a. m.	722.1	−5.4	56	wnw.	9.4	526	722.1	−5.4	56	wnw.	9.4
***Second flight*—**											
12.30 p. m.	721.9	−4.4	54	w.	8.9	526	721.9	−4.4	54	w.	8.9
12.42 p. m.	721.8	−4.4	54	wnw.	9.8	829	694.4	−9.1	50	wnw.	9.4
12.55 p. m.	721.7	−3.8	53	wnw.	10.7	1,048	674.8	−10.5	52	wnw.	8.3
1.01 p. m.	721.7	−3.8	53	wnw.	8.9	1,420	642.8	−14.5	59	wnw.	9.4
2.19 p. m.	721.1	−3.2	38	nw.	10.7	945	683.5	−8.4	45	wnw.	9.0
2.25 p. m.	721.1	−3.2	36	nw.	11.6	1,351	648.4	−12.4	46	wnw.	10.6
2.45 p. m.	721.1	−3.0	36	wnw.	13.4	2,016	593.6	−19.6	67	wnw.	12.4
2.54 p. m.	721.1	−3.1	34	wnw.	13.9	2,464	559.2	−17.6	52	wnw.	24.3
3.04 p. m.	721.1	−2.8	37	wnw.	12.1	2,777	536.0	−18.9	42	wnw.	22.6
3.09 p. m.	721.1	−2.9	39	wnw.	13.9	2,919	526.1	−18.1	36	wnw.	25.0
3.14 p. m.	721.1	−3.1	42	wnw.	14.3	2,988	521.0	−18.8	31	wnw.	24.9
3.21 p. m.	721.1	−3.2	47	wnw.	14.3	2,866	529.7	−18.2	28	wnw.	22.0
3.28 p. m.	721.1	−3.3	43	wnw.	14.8	2,749	537.8	−19.1	28	wnw.	24.4
3.53 p. m.	721.2	−3.9	40	wnw.	16.1	2,352	567.4	−16.3	22	wnw.	26.3
3.56 p. m.	721.2	−4.1	40	wnw.	19.7	2,302	571.0	−17.6	22	wnw.	24.4
4.02 p. m.	721.2	−4.0	41	wnw.	17.9	2,174	581.0	−17.1	23	wnw.	22.2
4.09 p. m.	721.2	−3.9	43	wnw.	16.5	2,034	591.8	−19.1	30	wnw.	19.4
4.20 p. m.	721.3	−4.0	46	wnw.	15.2	1,581	629.0	−16.1	45	wnw.	14.0
4.35 p. m.	721.4	−4.4	49	wnw.	16.1	1,187	662.4	−12.4	58	nw.	14.8
4.45 p. m.	721.4	−4.6	39	wnw.	15.2	902	687.4	−9.6	53	nw.	16.8
4.51 p. m.	721.5	−4.8	42	wnw.	16.5	526	721.5	−4.8	42	wnw.	16.5
***Third flight*—**											
5.45 p. m.	722.2	−6.2	53	wnw.	11.6	526	722.2	−6.2	53	wnw.	11.6
5.52 p. m.	722.3	−6.6	47	wnw.	13.9	912	687.2	−10.7	60	nw.	15.2
6.00 p. m.	722.4	−6.6	47	wnw.	13.9	1,188	663.0	−13.4	64	nw.	15.2
6.10 p. m.	722.5	−6.9	49	wnw.	13.9	1,614	626.8	−17.4	73	wnw.	14.8
6.15 p. m.	722.5	−7.0	51	wnw.	13.9	1,834	608.6	−19.2	76	wnw.	16.2
6.17 p. m.	722.6	−7.0	51	wnw.	13.9	1,979	596.9	−16.2	69	wnw.	24.6
6.25 p. m.	722.7	−7.2	54	wnw.	13.0	2,200	579.7	−17.5	52	wnw.	25.0
6.36 p. m.	722.7	−7.2	55	wnw.	14.3	2,560	552.5	−17.3	46	wnw.	24.2
6.50 p. m.	722.9	−7.4	61	wnw.	14.8	3,083	515.3	−19.1	38	wnw.	28.3
6.57 p. m.	723.0	−7.5	62	wnw.	15.2	3,220	505.6	−20.2	36	wnw.	27.7
7.12 p. m.	723.1	−7.7	64	wnw.	15.2	3,067	516.1	−19.4	30	wnw.	27.3
7.29 p. m.	723.1	−7.8	65	wnw.	16.5	2,558	552.5	−16.6	28	wnw.	25.7
7.40 p. m.	723.2	−7.8	65	wnw.	13.9	2,475	558.8	−17.5	30	wnw.	23.6
7.50 p. m.	723.3	−8.0	68	wnw.	13.4	2,155	583.1	−16.4	30	wnw.	22.8
7.52 p. m.	723.3	−8.1	69	wnw.	13.4	2,082	588.7	−17.4	30	wnw.	22.8
7.53 p. m.	723.3	−8.1	69	wnw.	13.4	2,048	591.4	−16.2	30	wnw.	22.8
7.55 p. m.	723.3	−8.2	70	wnw.	17.0	1,989	596.0	−17.6	30	wnw.	22.8
7.56 p. m.	723.3	−8.2	71	wnw.	17.0	1,944	599.6	−16.6	30	wnw.	23.2
7.59 p. m.	723.3	−8.2	71	wnw.	14.3	1,877	605.1	−19.6	34	wnw.	22.0
8.00 p. m.	723.3	−8.2	71	wnw.	14.3	1,856	606.8	−17.9	35	wnw.	22.0
8.05 p. m.	723.3	−8.2	71	wnw.	13.0	1,744	615.9	−20.0	44	wnw.	20.3
8.10 p. m.	723.4	−8.2	71	wnw.	13.4	1,702	619.5	−18.7	51	wnw.	19.6
8.11 p. m.	723.4	−8.2	71	wnw.	13.4	1,615	626.8	−19.6	57	wnw.	19.6
8.29 p. m.	723.5	−8.2	58	wnw.	17.0	1,183	664.0	−15.3	75	wnw.	17.9

March 1, 1912.—First flight: Four kites were used; lifting surface, 25.2 sq. m. Wire out, 5,000 m.; at maximum altitude, 4,900 m.

There were 2/10 to 8/10 St.-Cu. from the west-northwest; the altitude of their base, as determined from observations on kites between 10.30 and 11.30 a. m., was about 1,700 m.

At 8 a. m. high pressure (781 mm.) was central over North Dakota and low pressure (762 mm.) over New Brunswick.

Second flight: Three kites were used; lifting surface, 18.9 sq. m. Wire out, 5,000 m., at maximum altitude.

St.-Cu., from the west-northwest, decreased from 3/10 to few by 3 p. m.

Results of free air observations.

Date and hour.	On Mount Weather, Va. 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Mar. 1, 1912—Con.											
Third flight—Con.	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%		*m. p. s.*
8.40 p. m.	723.7	−8.2	56	wnw.	17.0	914	688.2	−12.5	73	nw.	18.3
8.49 p. m.	723.7	−8.4	64	wnw.	13.0	526	723.7	− 8.4	64	wnw.	13.0
Fourth flight—											
9.46 p. m.	724.2	−8.6	63	wnw.	9.8	526	724.2	− 8.6	63	wnw.	9.8
9.56 p. m.	724.4	−8.6	63	wnw.	13.9	921	688.2	−12.4	68	wnw.	18.3
10.13 p. m.	724.4	−8.7	61	wnw.	12.5	1,114	670.8	−14.2	73	wnw.	15.8
10.26 p. m.	724.4	−8.8	63	wnw.	12.5	1,622	627.0	−18.5	82	wnw.	15.7
10.38 p. m.	724.5	−8.8	63	wnw.	13.0	1,770	615.1	−12.6	47	wnw.	20.7
10.44 p. m.	724.5	−8.8	63	wnw.	14.3	2,125	587.0	−14.0	38	wnw.	22.0
10.57 p. m.	724.5	−8.9	59	wnw.	15.2	2,544	555.4	−15.4	35	wnw.	22.8
11.09 p. m.	724.5	−9.0	59	wnw.	17.0	2,889	530.4	−17.8	33	wnw.	23.1
11.22 p. m.	724.6	−9.2	64	wnw.	16.1	2,555	554.5	−16.3	31	wnw.	22.3
11.35 p. m.	724.6	−9.4	68	wnw.	12.5	2,138	586.0	−14.5	31	wnw.	22.3
11.48 p. m.	724.7	−9.4	69	wnw.	13.9	1,825	610.6	−13.0	27	wnw.	18.3
12.00 mdt.	724.7	−9.4	69	wnw.	12.5	1,396	646.2	−17.2	48	wnw.	20.3
Mar. 2, 1912:											
12.21 a. m.	724.8	−9.5	68	wnw.	14.8	1,074	674.6	−14.9	75	wnw.	16.4
12.32 a. m.	724.8	−9.6	68	wnw.	13.9	868	693.2	−13.3	78	wnw.	16.8
12.38 a. m.	724.8	−9.7	68	wnw.	13.4	526	724.8	− 9.7	68	wnw.	13.4
Mar. 2, 1912:											
First flight—											
1.10 a. m.	725.0	− 9.8	70	wnw.	7.2	526	725.0	− 9.8	70	wnw.	7.2
1.20 a. m.	725.0	− 9.8	74	wnw.	6.7	944	686.5	−13.8	77	wnw.	13.3
1.30 a. m.	725.1	− 9.8	74	wnw.	7.6	1,247	659.6	−16.5	86	wnw.	14.4
2.00 a. m.	725.3	− 9.8	74	wnw.	7.6	1,744	617.2	−20.4	86	wnw.	14.8
2.29 a. m.	725.3	− 9.9	74	wnw.	8.9	1,863	607.4	−16.1	57	wnw.	20.7
2.32 a. m.	725.4	− 9.9	74	wnw.	8.5	2,012	595.6	−16.2	51	wnw.	18.7
2.36 a. m.	725.4	− 9.9	74	wnw.	8.5	2,342	570.1	−16.8	49	wnw.	21.8
2.41 a. m.	725.4	− 9.9	74	wnw.	9.4	2,269	575.6	−16.2	48	wnw.	20.9
2.54 a. m.	725.4	− 9.9	74	wnw.	8.5	2,069	591.0	−16.7	47	wnw.	20.9
2.59 a. m.	725.4	− 9.9	74	wnw.	8.5	1,810	611.8	−18.1	48	wnw.	21.3
3.03 a. m.	725.4	− 9.9	73	wnw.	9.4	1,732	618.2	−20.7	58	wnw.	20.3
3.26 a. m.	725.4	−10.2	73	wnw.	8.9	1,506	637.3	−19.1	83	wnw.	15.6
3.45 a. m.	725.5	−10.4	73	wnw.	9.4	1,177	666.2	−16.2	87	wnw.	16.4
3.56 a. m.	725.5	−10.4	73	wnw.	9.4	905	690.4	−14.1	86	wnw.	14.0
4.03 a. m.	725.5	−10.4	73	nw.	9.4	526	725.5	−10.4	73	nw.	9.4
Second flight.											
4.35 a. m.	725.6	−10.6	72	wnw.	8.9	526	725.6	−10.6	72	wnw.	8.9
4.44 a. m.	725.6	−10.6	72	wnw.	8.5	915	689.6	−14.2	84	wnw.	12.9
4.55 a. m.	725.6	−10.5	72	wnw.	10.3	1,185	665.4	−16.4	90	wnw.	14.8
5.10 a. m.	725.6	−10.6	71	wnw.	8.0	1,769	615.5	−19.9	86	wnw.	20.3
5.20 a. m.	725.7	−10.6	72	wnw.	8.0	1,945	601.1	−16.4	71	wnw.	24.7
5.31 a. m.	725.7	−10.6	72	wnw.	8.0	2,176	583.0	−16.4	55	wnw.	23.4
5.46 a. m.	725.8	−10.8	77	wnw.	7.2	2,657	547.0	−16.4	42	wnw.	27.3
6.04 a. m.	725.8	−10.8	78	wnw.	7.6	2,286	574.8	−16.3	40	wnw.	24.8
6.23 a. m.	726.0	−11.0	76	wnw.	8.9	2,040	593.8	−15.3	41	wnw.	22.4
6.29 a. m.	726.0	−11.2	81	wnw.	8.0	1,825	611.0	−16.3	43	wnw.	22.4
6.42 a. m.	726.1	−11.4	85	wnw.	6.3	1,606	629.2	−19.7	72	wnw.	16.0
7.05 a. m.	726.2	−11.5	86	wnw.	8.0	1,080	675.0	−15.8	86	wnw.	14.0
7.14 a. m.	726.3	−11.4	86	wnw.	8.5	865	694.6	−14.4	84	wnw.	11.7
7.18 a. m.	726.3	−11.2	86	wnw.	8.5	526	726.3	−11.2	86	wnw.	8.5

Third flight: Three kites were used; lifting surface, 18.9 sq. m. Wire out, 5,000 m., at maximum altitude.

St.-Cu., from the west-northwest, increased from few to 2/10 by 8.20 p. m.

At 8 p. m. high pressure (782 mm.) was central over Manitoba and low pressure (763 mm.) over New Brunswick.

Fourth flight: Three kites were used; lifting surface, 18.9 sq. m. Wire out, 5,000 m., at maximum altitude.

Tnere were 6/10 to 8/10 St.-Cu., from the west-northwest.

March 2, 1912.—First flight: Three kites were used; lifting surface, 18.9 sq. m. Wire out, 5,000 m., at maximum altitude.

There were 6/10 to 9/10 St.-Cu., from the west-northwest.

Second flight: Four kites were used; lifting surface, 25.2 sq. m. Wire out, 5,000 m., at maximum altitude.

St.-Cu., from the west-northwest, decreased from 8/10 to 3/10. Head kite emerged from the clouds at 6.45 a. m.; altitude, 1,500 m.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Mar. 2, 1912—Con.											
Third flight—	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%		*m. p. s.*
8.12 a. m....	726.6	−10.6	86	nw.	4.9	526	726.6	−10.6	86	nw.	4.9
8.30 a. m....	726.7	−10.4	76	wnw.	6.7	1,073	676.4	−15.9	85	wnw.	8.2
8.51 a. m....	726.8	− 9.8	66	wnw.	8.9	1,676	624.2	−19.4	84	wnw.	14.0
9.05 a. m....	726.9	− 9.2	59	wnw.	11.6	1,875	608.0	−14.3	50	wnw.	19.3
9.12 a. m....	726.8	− 9.4	61	wnw.	8.9	2,106	589.7	−14.7	43	wnw.	18.7
9.29 a. m....	726.8	− 9.2	62	nw.	9.8	2,901	531.3	−13.6	31	wnw.	29.9
9.47 a. m....	726.7	− 9.0	66	wnw.	10.7	3,026	522.6	−14.0	21	wnw.	28.1
9.57 a. m....	726.6	− 8.8	62	wnw.	15.2	2,906	531.3	−13.4	21	wnw.	23.7
10.09 a. m....	726.6	− 8.6	58	wnw.	14.8	2,595	553.6	−14.1	20	wnw.	21.3
10.25 a. m....	726.5	− 8.5	56	wnw.	12.1	2,102	590.6	−13.4	21	wnw.	16.4
10.30 a. m....	726.4	− 8.3	53	wnw.	9.4	1,758	617.8	−14.1	22	wnw.	13.3
10.33 a. m....	726.4	− 8.2	52	wnw.	9.4	1,548	635.2	−17.4	25	wnw.	10.9
10.56 a. m....	726.3	− 7.6	52	nw.	9.8	1,020	681.2	−12.9	56	wnw.	....
11.04 a. m....	726.3	− 7.6	50	wnw.	8.9	526	726.3	− 7.6	50	wnw.	8.9
Fourth flight—											
11.36 a. m....	726.2	− 7.0	56	wnw.	10.3	526	726.2	− 7.0	56	wnw.	10.3
11.49 a. m....	726.1	− 6.4	58	wnw.	9.4	858	695.6	−11.7	54	wnw.	8.2
12.34 p. m....	725.8	− 6.1	49	wnw.	11.6	1,052	677.9	−13.0	61	wnw.	9.4
12.43 p. m....	725.7	− 5.5	48	wnw.	8.9	1,473	641.2	−16.5	63	wnw.	11.1
12.46 p. m....	725.7	− 5.3	47	wnw.	8.9	1,703	621.9	−14.1	58	wnw.	18.6
12.55 p. m....	725.6	− 4.7	46	wnw.	11.2	2,078	592.0	−13.7	39	wnw.	19.3
1.07 p. m....	725.5	− 5.0	46	wnw.	9.4	2,341	572.0	−13.0	27	wnw.	18.7
1.18 p. m....	725.4	− 5.0	47	wnw.	9.8	2,733	543.2	−13.0	21	wnw.	22.7
1.21 p. m....	725.4	− 5.0	47	wnw.	9.4	2,872	533.6	−11.6	17	wnw.	27.0
1.25 p. m....	725.3	− 5.0	47	wnw.	10.3	2,776	540.7	−12.4	16	wnw.	25.0
2.09 p. m....	724.9	− 4.4	41	wnw.	9.8	2,380	569.3	−11.8	9	wnw.	19.9
2.19 p. m....	724.8	− 4.5	42	wnw.	10.7	2,209	582.1	−13.0	9	wnw.	19.1
2.29 p. m....	724.8	− 4.0	44	wnw.	9.8	2,142	587.4	−11.4	9	wnw.	19.0
2.38 p. m....	724.8	− 3.9	45	nw.	11.2	1,704	621.9	−12.9	9	wnw.	16.2
2.40 p. m....	724.8	− 3.8	46	nw.	11.2	1,562	633.8	−14.3	10	wnw.	12.7
2.50 p. m....	724.7	− 4.0	43	nw.	11.2	1,329	653.2	−13.5	28	wnw.	12.7
3.02 p. m....	724.7	− 3.8	38	nw.	12.5	936	687.6	− 9.4	39	nw.	10.1
3.10 p. m....	724.6	− 3.8	42	wnw.	9.8	526	724.6	− 3.8	42	wnw.	9.8
March 3, 1912:											
3.13 p. m....	725.7	− 6.8	84	e.	6.3	526	725.7	− 6.8	84	e.	6.3
4.13 p. m....	725.1	− 6.6	84	e.	7.2	773	702.4	− 9.1	86	se.	3.7
4.17 p. m....	725.1	− 6.6	84	e.	6.7	1,005	681.5	−10.2	89	sse.	4.2
4.24 p. m....	725.1	− 6.6	84	e.	6.7	1,436	644.6	− 9.1	88	ssw.	10.0
4.30 p. m....	725.0	− 6.6	80	ese.	5.8	1,181	666.2	−10.8	92	ssw.	5.4
4.41 p. m....	725.0	− 6.8	84	ese.	5.8	795	700.3	− 9.8	89	ese.	6.8
4.47 p. m....	725.0	− 7.0	84	ese.	5.4	526	725.0	− 7.0	84	ese.	5.4

Third flight.—Four kites were used; lifting surface, 27.2 sq. m. Wire out, 5,000 m., at maximum altitude.

St.-Cu., from the west-northwest, decreased from 6/10 to few by 10.30 a. m. Head kite entered the clouds at 8.37 a. m.; altitude, 1,200 m.

At 8 a. m. high pressure (782 mm.) was central over northern Minnesota and low pressure (757 mm.) over New Brunswick.

Fourth flight.—Four kites were used; lifting surface, 27.2 sq. m. Wire out, 5,500 m.; at maximum altitude, 4,700 m.

St.-Cu., from the west-northwest, decreased from 2/10 to none by 1 p. m. After 11.45 a. m. there were few to 2/10 Ci. from the west.

At 8 p. m. high pressure (782 mm.) was central over northern Wisconsin and low pressure (764 mm.) over New Brunswick.

March 3, 1912.—Four kites were used; lifting surface, 31.1 sq. m. Wire out, 2,200 m.; at maximum altitude, 1,000 m.

A.-Cu., from the west, and St.-Cu., from the southeast, varied from 6/10 to 8/10. Light snow fell at intervals.

High pressure (783 mm.) central north of Lake Huron, covered the United States except the southwest.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Mar. 4, 1912.											
First flight—	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%		*m. p. s.*
8.29 a. m....	724.8	−8.2	100	ese.	6.7	526	724.8	−8.2	100	ese.	6.7
9.15 a. m....	724.8	−8.0	100	ese.	5.8	677	710.9	−5.5	82	se.	3.7
9.20 a. m....	724.8	−7.9	100	ese.	6.3	890	691.8	−6.2	84	se.	6.8
9.26 a. m....	724.8	−7.8	100	ese.	5.8	526	724.8	−7.8	100	ese.	5.8
Second flight—											
3.15 p. m....	722.3	−6.2	98	se.	7.6	526	722.3	−6.2	98	se.	7.6
3.22 p. m....	722.3	−6.0	98	se.	7.6	750	701.8	−7.5	99	sse.	9.4
3.35 p. m....	722.3	−6.0	98	se.	7.6	1,146	667.2	−6.1	99	ssw.	10.2
3.42 p. m....	722.3	−6.0	98	se.	7.6	1,281	655.8	−2.4	100	sw.	11.0
3.50 p. m....	722.3	−6.0	98	se.	7.2	1,731	619.6	−4.7	96	wsw.	15.2
4.03 p. m....	722.3	−5.8	98	se.	8.0	1,282	655.8	−1.4	87	sw.	12.1
4.06 p. m....	722.3	−5.9	98	se.	7.6	1,147	667.2	−5.8	97	ssw.	10.5
4.11 p. m....	722.3	−6.0	98	se.	7.2	739	702.8	−7.4	98	s.	8.6
4.19 p. m....	722.3	−5.9	98	se.	6.3	526	722.3	−5.9	98	se.	6.3
Mar. 5, 1912:											
8.43 a. m...	725.3	−5.2	95	nnw.	7.6	526	725.3	−5.2	95	nnw.	7.6
8.52 a. m...	725.6	−5.6	94	nnw.	8.0	856	695.6	−8.4	92	n.	9.4
9.10 a. m...	725.8	−6.3	92	nnw	8.5	1,121	672.3	−8.2	76	n.	8.2
10.25 a. m...	727.0	−5.8	95	nw.	9.8	1,487	642.3	−10.2	71	n.	4.0
10.50 a. m...	727.4	−5.5	89	nw.	8.0	941	689.7	−7.5	57	n.	8.6
10.57 a. m...	727.5	−5.3	90	nw.	8.0	832	699.6	−7.9	78	n.	8.6
11.03 a. m...	727.5	−5.2	90	nw.	8.5	526	727.5	−5.2	90	nw.	8.5
Mar. 6, 1912:											
8.04 a. m...	724.4	−7.6	100	e.	5.8	526	724.4	−7.6	100	e.	5.8
8.22 a. m...	724.3	−7.0	100	e.	4.5	998	681.6	−8.4	100	e.	16.3
8.27 a. m...	724.3	−7.0	100	e.	4.9	1,221	662.4	−6.3	100	se.	16.7
9.55 a. m...	724.1	−7.2	98	ne.	4.0	1,670	625.3	−6.7	100	sse.	7.6
9.57 a. m...	724.1	−7.2	98	ne.	4.0	1,878	608.9	−4.4	100	sse.	7.6
10.03 a. m...	724.1	−7.3	98	e.	4.0	2,229	582.5	−4.7	100	s.	11.7
10.12 a. m...	724.0	−7.2	95	e.	4.5	2,478	564.5	−4.2	100	s.	15.8
10.20 a. m...	723.9	−7.1	97	ne.	4.0	2,175	587.1	−4.7	100	sse.	14.4
10.44 a. m...	723.7	−6.6	95	ne.	5.4	1,606	630.8	−3.1	100	se.	11.2
10.46 a. m...	723.7	−6.6	95	ne.	5.4	1,379	649.2	−5.5	100	se.	12.7
11.00 a. m...	723.6	−6.2	95	ne.	3.6	939	686.5	−4.4	100	ese.	14.6
11.11 a. m...	723.5	−6.0	95	ne.	5.4	526	723.5	−6.0	95	ne.	5.4

March 4, 1912.—First flight: Three kites were used; lifting surface, 18.9 sq. m. Wire out, 1,600 m.; at maximum altitude, 700 m.

There was dense fog.

Second flight: Three kites were used; lifting surface, 18.9 sq. m. Wire out, 2,300 m.; at maximum altitude, 2,100 m.

There were 10/10 St. from the southeast at an altitude of 650 m.

Low pressure (767 mm.) was central off the Carolina coast and high pressure (782 mm.) over Saskatchewan.

March 5, 1912.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 3,700 m.; at maximum altitude, 2,900 m.

St. from the north decreased from 10/10 to none, and Ci.-St., Ci.-Cu., and A.-Cu. from the west, and St.-Cu. from the north increased to 10/10 before 10 a. m. There after they decreased to 6/10. Snow began at 8.20 a. m. and ended at 8.50 a. m. A solar halo was observed after 10.30 a. m. The head kite entered the St., altitude 650 m., at 8.45 a. m. St. passed from under the kite at 9.13 a. m.

High pressure (783 mm.), central over Lake Huron, covered the entire United States except the Pacific coast.

March 6, 1912.—Five kites were used; lifting surface, 32.0 sq. m. Wire out, 5,000 m.; at maximum altitude, 3,300 m.

There were 10/10 St. from the east-southeast. Light snow fell. The head kite was in St. from 8.20 until 11.05 a. m., altitude about 900 m.

High pressure (780 mm.) was central over New England, low pressure (763 mm.) over Cuba.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
March 8, 1912:	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%		*m. p. s.*
7.59 a. m....	716.7	1.8	86	se.	5.4	526	716.7	1.8	86	se.	5.4
8.10 a. m....	716.7	1.2	89	se.	....	705	701.2	5.5	79	s.	....
8.40 a. m....	716.6	1.5	84	se.	....	688	702.6	7.4	70	s.	....
8.55 a. m....	716.5	0.5	94	se.	5.4	846	689.1	5.4	69	ssw.	....
9.24 a. m....	716.4	0.4	96	se.	4.9	1,474	637.4	1.1	69	ssw.	....
9.43 a. m....	716.3	0.6	96	se.	5.8	904	683.7	5.3	70	s.	....
9.50 a. m....	716.3	0.8	93	se.	6.3	526	716.3	0.8	93	se.	6.3
Mar. 9, 1912:											
11.35 a. m...	711.6	−0.8	96	wnw.	17.0	526	711.6	−0.8	96	wnw.	17.0
11.43 a. m...	711.6	−0.8	96	wnw.	16.5	878	680.7	−4.1	100	nw.	22.6
11.47 a. m...	711.6	−0.8	94	wnw.	17.0	939	675.5	−3.0	87	nnw.	23.5
11.52 a. m...	711.6	−0.8	94	wnw.	16.5	984	671.6	−4.0	81	nnw.	27.5
11.58 a. m...	711.6	−0.8	94	wnw.	15.6	1,352	641.3	0.2	72	nw.	18.4
12.22 p. m...	711.5	−0.6	90	wnw.	13.9	1,872	600.7	−2.8	73	nw.	11.7
12.32 p. m...	711.5	−0.5	86	wnw.	....	1,929	597.1	−6.4	78	wnw.	13.9
12.47 p. m...	711.4	−0.2	87	wnw.	15.6	2,581	548.2	−9.3	83	wnw.	10.9
1.12 p. m...	711.4	−0.3	81	wnw.	17.9	1,989	591.1	−2.4	69	nw.	15.9
1.17 p. m...	711.4	−0.4	81	wnw.	20.6	1,781	606.8	−3.5	68	nw.	17.0
1.22 p. m...	711.4	−0.5	80	wnw.	17.9	1,657	616.4	−2.8	65	nw.	17.8
1.35 p. m...	711.3	−0.4	79	wnw.	17.9	1,232	650.5	−7.0	72	nnw.	23.0
1.47 p. m...	711.3	−0.4	75	wnw.	19.7	890	679.4	−4.5	90	nnw.	23.4
1.58 p. m...	711.3	−0.1	72	wnw.	15.2	526	711.3	−0.1	72	wnw.	15.2
Mar. 10, 1912:											
11.13 a. m...	716.2	−4.8	57	wnw.	17.4	526	716.2	− 4.8	57	wnw.	17.4
11.20 a. m...	716.2	−5.0	60	wnw.	15.2	861	686.1	−10.2	55	nw.	20.4
11.25 a. m...	716.2	−4.6	49	wnw.	15.2	1,073	667.5	− 8.4	46	nw.	22.5
11.32 a. m...	716.1	−4.2	50	wnw.	13.0	1,149	660.9	−12.1	45	nnw.	21.4
11.36 a. m...	716.1	−4.2	50	wnw.	13.9	1,295	648.5	− 6.1	37	nnw.	23.6
11.44 a. m...	716.1	−3.9	46	wnw.	12.5	1,823	606.1	− 8.1	35	nnw.	20.4
12.04 p. m...	716.0	−3.4	47	wnw.	16.5	2,504	554.9	−12.5	30	nnw.	23.5
12.22 p. m...	715.9	−3.0	44	wnw.	12.1	3,094	513.6	−16.7	30	nnw.	24.2
12.50 p. m...	715.8	−2.3	55	wnw.	12.5	2,405	562.4	− 9.8	28	nw.	23.4
1.00 p. m...	715.8	−2.3	52	wnw.	10.7	1,702	615.8	− 6.9	28	nw.	22.4
1.07 p. m...	715.8	−2.0	48	wnw.	11.2	1,643	620.5	−11.1	26	nw.	25.1
1.15 p. m...	715.7	−1.5	45	wnw.	15.6	1,385	641.5	− 6.7	21	nw.	20.0
1.22 p. m...	715.7	−1.4	44	wnw.	14.3	1,226	654.5	− 9.1	21	nw.	22.4
1.32 p. m...	715.6	−1.4	44	wnw.	13.9	907	682.0	− 6.4	29	wnw.	18.4
1.40 p. m...	715.6	−1.2	46	wnw.	13.9	526	715.6	− 1.2	46	wnw.	13.9

March 8, 1912.—Four kites were used; lifting surface, 27.2 sq. m. Wire out, 2,800 m.; at maximum altitude, 2,100 m.

At the beginning the sky was covered with A.-Cu. from the west.

There was light fog after 8.20 a. m., becoming dense at intervals after 8.50 a. m. The head kite was in fog from 8.55 to 9.25 a. m. and after 9.45 a. m.

High pressure (780 mm.) was central over South Dakota. Pressure (761 mm.) was low over Ohio.

March 9, 1912.—Four kites were used; lifting surface, 21.5 sq. m. Wire out, 5,000 m.; at maximum altitude, 4,300 m.

There were 10/10 St. and St.-Cu. from the northwest; altitude of St., about 800 m.

Low pressure (757 mm.), central over Maine, extended southward to the Carolinas. High pressure (777 mm.) was central over Kansas.

March 10, 1912.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 5,000 m.; at maximum altitude, 4,800 m.

The sky was cloudless.

Low pressure (749 mm.) was central off the New England coast.

High pressure (773 mm.) was central over the middle Mississippi Valley.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Mar. 11, 1912:	*mm.*	*C.*	%		*m.p.s.*	*m.*	*mm.*	*C.*	%		*m.p.s.*
1.20 p. m....	719.3	−0.6	55	se.	6.7	526	719.3	− 0.6	55	se.	6.7
1.37 p. m....	719.1	−0.3	58	se.	7.2	983	678.8	− 5.7	56	sse.	12.3
1.46 p. m....	719.0	0.0	57	se.	8.0	1,090	669.5	− 6.2	56	ssw.	11.3
1.48 p. m....	719.0	0.1	57	se.	8.0	1,215	659.0	− 3.8	53	ssw.	11.3
1.54 p. m....	719.0	0.2	57	se.	8.9	1,508	665.0	− 4.9	34	ssw.	12.2
1.57 p. m....	718.9	0.1	57	se.	8.9	1,593	628.1	− 4.4	32	ssw.	14.3
2.17 p. m....	718.8	0.6	51	se.	9.8	2,120	587.3	− 6.2	26	sw.	14.3
2.47 p. m....	718.6	0.8	52	se.	9.4	2,640	549.4	− 6.8	27	sw.	14.7
3.41 p. m....	718.4	0.6	58	se.	9.4	2,989	525.0	−10.4	61	sw.	6.4
3.56 p. m....	718.3	0.4	58	se.	8.9	3,295	504.4	−13.0	83	sw.	....
4.28 p. m....	718.3	0.6	58	se.	9.8	2,275	575.2	− 6.2	66	sw.	13.8
4.43 p. m....	718.2	0.4	60	se.	9.8	1,795	611.4	− 4.4	74	sw.	13.8
4.51 p. m....	718.2	0.4	58	se.	8.9	1,555	630.4	− 7.6	67	sw.	12.8
5.07 p. m....	718.2	0.4	58	se.	8.9	1,007	676.1	− 4.3	62	sse.	8.9
5.15 p. m....	718.2	0.0	58	se.	8.9	526	718.2	0.0	58	se.	8.9
Mar. 12, 1912:											
1.32 p. m....	709.6	0.0	100	sse.	8.2	526	709.6	0.0	100	sse.	8.2
1.43 p. m....	709.4	−0.1	100	sse.	8.2	981	670.6	6.0	93	ssw.	21.5
1.50 p. m....	709.3	−0.1	100	sse.	10.2	1,384	638.3	5.1	93	sw.	21.4
2.08 p. m....	709.0	−0.1	100	sse.	9.5	2,091	584.7	0.0	100	sw.	21.2
2.28 p. m....	708.7	0.0	100	sse.	9.5	1,349	640.6	5.1	93	ssw.	17.8
2.35 p. m....	708.6	0.0	100	sse.	6.1	1,020	666.7	6.7	93	ssw.	15.8
2.46 p. m....	708.4	0.0	100	sse.	6.1	526	708.4	0.0	100	sse.	6.1
Mar. 13, 1912:											
1.30 p. m....	709.4	4.0	76	nw.	16.1	526	709.4	4.0	76	nw.	16.1
1.36 p. m....	709.4	3.9	75	nw.	17.0	903	677.0	0.2	77	nw.	22.4
1.59 p. m....	709.6	3.8	76	nw.	15.2	1,232	650.0	−2.5	81	wnw.	21.9
2.20 p. m....	709.6	4.0	74	nw.	17.9	1,765	607.6	−4.6	81	wnw.	30.7
2.21 p. m....	709.6	4.0	74	nw.	19.7	1,811	603.9	−2.5	81	wnw.	30.7
2.33 p. m....	709.6	3.7	74	nw.	18.8	2,020	588.3	−1.5	64	wnw.	21.3
2.49 p. m....	709.6	3.6	74	nw.	22.4	2,310	567.5	−3.8	60	wnw.	28.4
3.10 p. m....	709.7	3.2	73	wnw.	24.1	1,880	599.2	0.1	57	wnw.	26.7
3.27 p. m....	709.9	3.0	75	wnw.	19.7	1,417	634.9	0.9	56	nw.	27.8
3.33 p. m....	709.9	3.0	76	wnw.	19.7	1,387	637.2	−3.1	69	nw.	30.6
3.45 p. m....	710.0	2.7	76	nw.	22.4	1,186	653.6	−3.6	79	nw.	28.4
4.04 p. m....	710.2	2.6	75	nw.	22.4	863	681.0	−1.3	83	nw.	26.5
4.13 p. m....	710.2	2.6	78	nw.	22.4	526	710.2	2.6	78	nw.	22.4

March 11, 1912.—Six kites were used; lifting surface, 39.8 sq. m. Wire out, 6,300 m.; at maximum altitude, 5,000 m.

The sky was covered with Ci.-St., from the west-northwest, and A.-St., from the southwest, until 3.20 p. m.; thereafter, with A.-St. only. The head kite was in A.-St., altitude, 3,000 m., from 3.49 to 4.03 p. m.

High pressure (770 mm.) was central over Pennsylvania. Low pressure was central over Kansas.

March 12, 1912.—Two kites were used; lifting surface, 12.6 sq. m. Wire out, 2,200 m.; at maximum altitude, 2,100 m.

There was dense fog. Light rain fell after 1.38 p. m.

Centers of low pressure (755 mm.) lay over Kentucky and over Georgia. Pressure was high (770 mm.) off the Atlantic coast.

March 13, 1912.—Three kites were used; lifting surface, 16.2 sq. m. Wire out, 4,400 m.; at maximum altitude, 4,100 m.

There were 5/10 to 8/10 A.-Cu., from the west, and St.-Cu., from the west-northwest. The head kite was in St.-Cu., at 2.01 p. m., altitude, 1,300 m.

Low pressure (748 mm.) was central over Rhode Island. A ridge of high pressure extended over the Missouri and lower Mississippi valleys with centers over North Dakota (769 mm.) and over Mississippi (767 mm.).

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Mar. 14, 1912:	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%		*m. p. s.*
1.23 p.m...	719.0	5.9	64	sse.	8.5	526	719.0	5.9	64	sse.	8.5
1.39 p.m...	718.9	6.0	63	se.	7.2	961	681.4	0.6	83	sse.	11.6
1.52 p.m...	718.8	5.8	64	se.	8.5	1,187	662.3	0.5	65	ssw.	12.9
1.57 p.m...	718.7	5.8	64	se.	10.7	1,422	643.4	4.5	45	ssw.	14.3
2.19 p.m...	718.6	5.6	65	se.	9.4	2,380	571.6	1.0	24	sw.	21.5
2.37 p.m...	718.5	5.8	65	se.	8.5	3,078	523.9	−2.1	24	sw.	27.2
3.03 p.m...	718.4	6.2	65	se.	8.5	2,255	580.7	1.7	22	sw.	17.8
3.16 p.m...	718.4	6.3	65	se.	9.4	1,604	629.2	5.1	18	ssw.	16.1
3.20 p.m...	718.4	6.4	65	se.	8.9	1,317	651.7	3.4	18	ssw.	10.8
3.29 p.m...	718.4	6.4	63	se.	10.3	1,216	659.9	5.3	21	sse.	11.6
3.31 p.m...	718.3	6.4	63	se.	11.6	1,039	674.3	1.5	31	sse.	17.2
3.37 p.m...	718.3	6.4	63	se.	12.1	970	680.2	1.6	64	sse.	15.5
3.46 p.m...	718.3	6.3	64	se.	12.5	526	718.3	6.3	64	se.	12.5
Mar. 15, 1912:											
5.49 p.m...	703.8	8.5	96	wnw.	13.4	526	703.8	8.5	96	wnw.	13.4
5.52 p.m...	703.8	8.6	95	wnw.	14.8	828	678.6	7.6	80	wnw.	25.7
6.00 p.m...	703.9	9.0	89	wnw.	14.3	1,089	657.4	6.4	80	w.	23.7
6.02 p.m...	703.9	8.9	77	wnw.	13.9	1,237	645.8	6.9	77	w.	23.5
6.16 p.m...	704.0	9.0	88	wnw.	14.8	1,585	619.0	4.5	65	w.	25.0
6.25 p.m...	704.1	8.9	88	wnw.	13.4	2,023	586.5	0.4	53	w.	26.3
6.30 p.m...	704.2	8.9	88	wnw.	12.5	2,258	569.6	−1.8	60	w.	26.5
6.34 p.m...	704.2	9.0	87	wnw.	13.9	2,357	562.2	−1.2	48	w.	26.4
6.38 p.m...	704.2	8.9	87	wnw.	14.8	2,265	568.4	−2.0	42	w.	32.6
6.51 p.m...	704.3	8.8	83	wnw.	17.9	1,784	603.4	0.6	50	w.	30.5
6.52 p.m...	704.3	8.8	82	wnw.	17.9	1,722	608.3	−1.8	65	w.	30.5
7 02 p.m...	704.4	8.8	77	wnw.	18.8	1,599	617.8	0.2	83	w.	36.7
7.13 p.m...	704.5	8.4	75	wnw.	16.5	1,273	643.4	3.6	67	w.	33.7
7.24 p.m...	704.6	8.2	73	wnw.	17.9	984	666.5	6.6	60	wnw.	28.6
7.35 p.m...	704.8	8.4	65	wnw.	20.6	526	704.8	8.4	65	wnw.	20.6
Mar. 16, 1912:											
11.19 a.m...	722.5	1.4	63	nw.	13.4	526	722.5	1.4	63	nw.	13.4
11.34 a.m...	722.6	2.0	61	nw.	11.6	1,027	678.6	−5.1	78	nnw.	16.0
11.43.a.m...	722.6	2.2	60	nw.	12.1	1,447	643.7	1.0	55	nnw.	14.3
12.04 p.m...	722.6	2.4	58	nw.	10.7	1,776	617.8	−1.2	39	nnw.	10.3
12.54 p.m...	722.7	3.8	51	wnw.	7.6	2,114	592.5	−2.9	28	nnw.	7.0
1.05 p.m...	722.7	4.4	50	wnw.	7.6	1,797	616.6	−0.1	28	nnw.	8.7
1.08 p.m...	722.7	4.5	50	wnw.	7.2	1,525	637.9	0.8	28	nnw.	13.3
1.18 p.m...	722.8	4.4	50	wnw.	8.0	1,236	661.6	−4.1	28	nw.	11.3
1.28 p.m...	722.8	4.4	50	wnw.	7.6	526	722.8	4.4	50	wnw.	7.6

March 14, 1912.—Four kites were used; lifting surface, 27.7 sq. m. Wire out, 4,000 m.; at maximum altitude, 3,950 m.

The sky was covered with Ci.-St. from the west, until 1.50 p. m. Thereafter there were 10/10 A.-St. from the same direction. A halo was visible from 1.20 to 1.50 p. m.

At 8 a. m. high pressure (770 mm.) was central over the Virginia coast. Low pressure was central over Newfoundland (749 mm.) and over southeastern Kansas (752 mm.).

March 15, 1912.—Three kites were used; lifting surface, 16.1 sq. m. Wire out, 3,500 m. at maximum altitude.

10/10 A.-St. and St.-Cu. from the southeast decreased to few.

At 8 p. m. low pressure (747 mm.) was central over New England. High pressure (767 mm.) was central over Louisiana.

March 16, 1912.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 4,400 m.; at maximum altitude, 2,500 m.

There were 2/10 to a few St.-Cu. from the northwest before 1.20 p. m.

Low pressure was central over Nova Scotia (752 mm.) and high pressure over Kentucky (772 mm.).

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Mar. 17, 1912:	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%		*m. p. s.*
8.11 a. m.	727.5	2.6	65	sse.	8.5	526	727.5	2.6	65	sse.	8.5
8.17 a. m.	727.4	2.4	68	sse.	8.9	965	688.7	−0.8	65	sse.	13.9
8.33 a. m.	727.4	1.9	70	sse.	8.9	1,495	644.9	4.3	42	s.	13.9
9.02 a. m.	727.3	2.2	71	se.	9.4	2,006	605.2	−0.4	27	ssw.	10.6
9.07 a. m.	727.3	2.5	71	se.	9.4	2,220	589.4	0.3	26	ssw.	13.7
9.22 a. m.	727.3	3.2	69	se.	10.7	2,373	578.4	−0.3	20	ssw.	10.1
9.29 a. m.	727.3	3.1	69	se.	8.9	2,630	559.9	−2.0	17	ssw.	10.4
9.58 a. m.	727.2	4.2	65	se.	11.2	3,167	523.5	−2.7	14	ssw.	14.9
10.07 a. m.	727.2	4.8	64	se.	11.2	2,864	544.2	−1.2	15	ssw.	11.4
10.18 a. m.	727.1	5.2	61	se.	11.2	2,701	555.1	−1.8	15	ssw.	12.5
10.42 a. m.	726.9	5.4	59	se.	10.7	2,024	604.0	1.6	15	s.	11.5
10.43 a. m.	726.9	5.4	59	sse.	9.8	1,976	607.6	0.2	15	s.	12.5
10.54 a. m.	726.8	6.0	60	sse.	10.3	1,410	651.7	3.4	16	s.	19.7
11.00 a. m.	726.8	6.1	59	sse.	11.2	1,163	671.8	4.0	17	sse.	20.2
11.04 a. m.	726.8	6.0	57	sse.	11.2	978	687.4	−0.1	27	sse.	12.7
11.11 a. m.	726.8	5.8	60	sse.	10.7	526	726.8	5.8	60	sse.	10.7
Mar. 18, 1912:											
8.11 a. m.	719.2	10.1	62	w.	9.4	526	719.2	10.1	62	w.	9.4
8.20 a. m.	719.1	10.4	59	w.	8.9	985	680.5	9.3	56	wnw.	21.5
8.32 a. m.	719.1	10.6	60	w.	11.6	1,508	638.8	6.1	50	wnw.	18.9
8.55 a. m.	719.0	11.2	56	w.	13.0	2,357	575.2	− 0.8	62	w.	15.0
9.20 a. m.	719.0	12.0	52	w.	12.1	2,937	534.6	− 4.7	73	wsw.	31.0
9.21 a. m.	719.0	12.1	52	w.	12.1	3,183	518.4	− 4.4	73	wsw.	31.0
9.30 a. m.	718.9	12.6	51	w.	9.8	3,711	483.8	− 8.4	55	w.	30.8
10.08 a. m.	718.9	13.2	52	w.	7.2	2,843	539.9	− 4.1	49	w.	17.9
10.15 a. m.	718.9	13.3	53	w.	12.1	2,624	555.2	− 4.6	50	w.	20.6
10.18 a. m.	718.9	13.4	52	w.	12.1	2,500	564.0	− 5.4	56	w.	20.6
10.40 a. m.	718.9	14.2	47	w.	11.6	1,960	603.8	0.2	69	w.	18.9
10.55 a. m.	718.9	14.4	48	w.	10.7	1,429	644.8	4.6	62	w.	17.2
11.05 a. m.	718.9	14.6	41	w.	11.2	1,000	679.3	8.1	60	w.	9.0
11.16 a. m.	718.7	14.6	41	w.	13.4	526	718.7	14.6	41	w.	13.4

March 17, 1912.—Five kites were used; lifting surface, 33.5 sq. m. Wire out, 6,000 m.; at maximum altitude, 4,700 m.

The sky was cloudless.

High pressure (779 mm.) was central over Rhode Island and low pressure (753 mm.) over Minnesota.

March 18, 1912.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 5,500 m.; at maximum altitude, 5,400 m.

Ci.-St., from the west, decreased from 6/10 to 3/10 before 9.30 a. m. Thereafter 5/10 Ci.-St. and Ci.-Cu., from the west, decreased to 2/10. Parhelia were observed at 9 a. m.

High pressure (770 mm.), central over western North Carolina, covered the entire United States. Pressure was low (754 mm.) over the lower St. Lawrence.

Results of free-air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Mar. 19, 1912:	mm.	C.	%		m. p. s.	m.	mm.	C.	%		m. p. s.
7.44 a. m.	718.4	8.2	42	se.	7.2	526	718.4	8.2	42	se.	7.2
7.54 a. m.	718.5	8.6	37	se.	7.6	879	688.7	8.8	38	s.	12.8
8.20 a. m.	718.4	8.9	40	se.	8.0	1,599	630.8	4.5	48	sw.	15.8
8.29 a. m.	718.4	9.2	40	se.	7.6	2,108	592.3	− 1.4	63	wsw.	20.4
8.48 a. m.	718.3	9.6	40	se.	7.6	2,894	536.0	− 8.7	78	wsw.	20.7
8.57 a. m.	718.2	9.5	39	se.	8.0	2,786	543.4	− 8.1	94	wsw.	22.2
9.00 a. m.	718.2	9.4	38	se.	8.5	2,966	531.2	− 7.0	63	wsw.	21.2
9.10 a. m.	718.2	9.6	39	se.	8.5	3,615	488.2	−13.3	63	wsw.	23.8
9.21 a. m.	718.1	9.6	40	se.	8.0	3,848	473.5	−15.8	63	w.	25.9
9.29 a. m.	718.1	9.6	41	se.	8.0	3,981	465.0	−14.6	50	w.	24.5
9.57 a. m.	718.0	10.4	42	se.	9.4	4,551	431.5	−18.1	16	w.	25.9
10.09 a. m.	717.9	10.8	43	sse.	8.5	4,306	446.0	−16.7	16	w.	25.5
10.11 a. m.	717.9	10.9	43	sse.	8.5	4,195	452.4	−17.5	18	w.	25.5
10.33 a. m.	717.8	11.5	43	sse.	8.5	3,855	473.5	−14.3	66	w.	24.5
10.58 a. m.	717.6	12.3	43	se.	7.6	3,458	498.7	−10.6	60	wsw.	21.2
11.00 a. m.	717.6	12.3	43	se.	7.6	3,384	503.5	−11.1	68	wsw.	21.2
11.12 a. m.	717.5	12.8	39	se.	8.9	3,112	521.4	− 8.2	67	wsw.	18.8
11.21 a. m.	717.5	13.0	36	se.	8.0	2,616	555.4	− 5.1	87	wsw.	18.8
11.30 a. m.	717.4	12.8	35	se.	8.0	2,237	582.6	− 1.2	59	wsw.	14.4
11.40 a. m.	717.3	13.3	35	se.	8.5	1,958	603.1	1.3	63	sw.	14.4
11.50 a. m.	717.3	13.2	34	se.	7.2	1,594	630.8	5.0	65	sw.	14.8
11.59 a. m.	717.2	13.2	34	se.	7.2	964	680.7	10.9	51	ssw.	15.8
12.05 p. m.	717.2	13.3	36	se.	7.2	930	683.4	9.3	51	s.	15.9
12.10 p. m.	717.1	13.9	38	sse.	8.0	526	717.1	13.9	38	sse.	8.0
Mar. 20, 1912:											
8.02 a. m.	715.8	9.6	90	wnw.	7.6	526	715.8	9.6	90	wnw.	7.6
8.12 a. m.	715.9	9.6	90	wnw.	7.6	887	685.5	7.5	86	nw.	12.9
8.28 a. m.	716.0	10.2	88	wnw.	4.9	1,360	647.3	5.9	64	nw.	20.6
8.48 a. m.	716.2	10.3	84	wnw.	2.2	2,182	585.2	1.5	40	nw.	18.1
9.10 a. m.	716.3	10.9	81	w.	4.9	2,373	571.6	0.9	33	wnw.	15.9
9.14 a. m.	716.4	11.0	80	w.	4.9	2,551	559.2	1.7	26	wnw.	24.8
9.33 a. m.	716.5	11.3	78	wnw.	7.2	3,508	496.0	− 4.8	19	wnw.	27.5
9.35 a. m.	716.5	11.3	78	wnw.	7.2	3,570	492.2	− 4.3	17	wnw.	27.5
9.46 a. m.	716.5	11.5	77	wnw.	5.8	3,626	488.3	− 5.3	11	wnw.	27.7
10.17 a. m.	716.8	11.8	74	wnw.	7.6	2,864	537.2	− 1.8	13	wnw.	18.1
10.28 a. m.	716.9	12.4	70	wnw.	8.5	2,511	561.5	− 0.1	17	wnw.	17.2
10.30 a. m.	717.0	12.2	72	wnw.	8.5	2,354	572.8	− 0.6	17	wnw.	17.2
10.35 a. m.	717.0	11.9	73	wnw.	8.9	2,073	593.3	0.3	24	wnw.	15.1
10.50 a. m.	717.2	12.4	70	wnw.	8.9	1,238	658.0	4.0	74	wnw.	13.8
11.03 a. m.	717.3	12.2	70	wnw.	8.5	846	690.3	7.8	80	wnw.	11.0
11.10 a. m.	717.3	12.4	68	wnw.	8.0	526	717.3	12.4	70	wnw.	8.0

March 19, 1912.—Seven kites were used; lifting surface, 44.6 sq. m. Wire out, 7,400 m., at maximum altitude.

There were 5/10 to 1/10 St.-Cu., from the west-southwest, until 11.10 a. m., and 2/10 to 6/10 A.-Cu., from the west, after 10.20 a. m. The head kite was in St.-Cu. at 8.47 a. m.; altitude, about 2,900 m.

Pressure was high (767 mm.) off the Atlantic coast. Low pressure was central over Kansas (755 mm.) and over upper Michigan (756 mm.).

March 20, 1912.—Five kites were used; lifting surface, 34.0 sq. m. Wire out, 5,000 m.; at maximum altitude, 4,800 m.

A.-Cu. and St.-Cu., from the west-northwest, increased from 3/10 to 9/10 before 10 a. m. Thereafter there were 10/10 Ci.-St., from the west, and St.-Cu., from the west-northwest. The head kite was momentarily in passing St.-Cu. at 10.51 a. m., altitude, 1,250 m. A solar halo was visible at intervals after 10.20 a. m

Pressure was high (778 mm.) over North Dakota. Low pressure (753 mm.) was central over New Brunswick.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Mar. 21, 1912:	mm.	C.	%		m. p. s.	m.	mm.	C.	%		m. p. s.
7.08 p. m...	712.8	6.0	92	wnw.	6.3	526	712.8	6.0	92	wnw.	6.3
7.13 p. m...	712.9	5.8	93	wnw.	6.3	819	688.1	9.7	88	w.	23.9
7.21 p. m...	712.9	5.6	93	wnw.	8.0	906	680.9	10.5	81	w.	29.9
7.40 p. m...	713.1	3.8	97	wnw.	6.7	1,295	649.9	8.4	80	wsw.	33.0
8.06 p. m...	713.3	4.1	97	wnw.	9.8	897	682.1	10.9	76	w.	22.5
8.20 p. m...	713.4	4.4	97	wnw.	5.8	709	697.7	9.5	84	wnw.	19.4
8.22 p. m...	713.4	4.4	97	wnw.	5.4	526	713.4	4.4	97	wnw.	5.4
Mar. 22, 1912:											
8.11 a. m...	719.7	−1.8	75	wnw.	14.3	526	719.7	− 1.8	75	wnw.	14.3
8.25 a. m...	719.8	−1.8	71	nw.	15.2	857	690.3	− 6.2	84	nw.	22.4
8.35 a. m...	719.8	−2.1	75	nw.	14.8	1,213	659.3	− 9.1	90	nw.	27.5
8.48 a. m...	719.9	−2.2	75	nw.	16.1	1,547	632.1	0.0	50	wnw.	31.0
8.59 a. m...	719.9	−2.2	71	nw.	17.0	1,925	603.0	2.1	31	wnw.	22.4
9.13 a. m...	720.0	−2.2	71	nw.	17.9	2,443	565.6	0.0	23	wnw.	23.6
9.31 a. m...	720.2	−2.0	69	nw.	18.8	3,288	508.7	− 6.5	16	wnw.	30.9
10.10 a. m...	720.6	−2.0	63	nw.	16.1	2,317	575.6	− 1.2	13	wnw.	27.5
10.20 a. m...	720.7	−1.9	63	nw.	17.9	2,021	597.2	1.4	12	nw.	19.4
10.28 a. m...	720.8	−1.8	63	nw.	19.7	1,552	633.2	− 0.4	12	nw.	28.4
10.38 a. m...	721.0	−1.7	62	nw.	17.4	1,331	651.0	0.7	10	nw.	25.6
10.53 a. m...	721.0	−1.6	63	nw.	20.6	1,019	677.2	− 6.9	16	nw.	22.8
10.59 a. m...	721.1	−1.7	62	nw.	21.5	843	692.7	− 6.0	36	nw.	21.5
11.08 a. m...	721.1	−1.7	61	nw.	18.8	526	721.1	− 1.7	61	nw.	18.8
Mar. 23, 1912.											
8.13 a. m...	724.9	−3.6	68	ese.	8.5	526	724.9	−3.6	68	ese.	8.5
8.26 a. m...	724.8	−3.6	66	ese.	8.5	901	691.2	−4.7	75	s.	12.3
9.20 a. m...	724.6	−1.8	63	ese.	6.7	1,232	662.6	−6.5	92	ssw.	14.3
9.23 a. m...	724.6	−2.2	63	ese.	6.7	1,831	614.4	2.2	66	ssw.	18.3
9.50 a. m...	724.5	−1.6	60	ese.	7.6	2,186	588.1	0.8	32	ssw.	11.2
10.30 a. m...	724.2	−0.3	56	ese.	7.6	2,934	535.6	−1.8	19	ssw.	21.5
10.50 a. m...	724.1	0.2	57	ese.	8.5	2,313	579.0	−0.6	17	ssw.	11.2
11.15 a. m...	723.8	0.6	60	ese.	8.9	1,456	643.7	3.2	14	ssw.	20.5
11.21 a. m...	723.7	0.4	61	ese.	8.0	1,139	669.7	−6.0	19	sse.	17.9
11.28 a. m...	723.6	1.1	62	ese.	8.5	972	684.1	−5.3	42	sse.	12.3
11.37 a. m...	723.4	1.2	62	se.	8.9	526	723.4	1.2	60	se.	8.9

March 21, 1912.—Two kites were used; lifting surface, 14.6 sq. m. Wire out, 2,000 m., at maximum altitude.

St.-Cu., from the west, decreased from 7/10 to 3/10.

High pressure (771 mm.) was central over the middle St. Lawrence Valley, and low pressure (754 mm.) over western Pennsylvania.

March 22, 1912.—Four kites were used; lifting surface, 21.6 sq. m. Wire out, 5,000 m.; at maximum altitude, 4,800 m.

There were 3/10 to 6/10 A.-St. and Ci.-St. from the west and 3/10 to 6/10 St. from the northwest. The head kite was in the St. at 8.32 a. m., altitude, 1,100 m. There was a halo at 9.45 a. m.

High pressure (776 mm.) was central over Iowa. Low pressure (742 mm.) was central over Newfoundland, and there was a slight depression (764 mm.) over South Carolina.

March 23, 1912.—Five kites were used; lifting surface, 32.0 sq. m. Wire out, 4,400 m.; at maximum altitude, 3,600 m.

10/10 St.-Cu., from the south-southwest, decreased to none at 10 a. m. After 9.10 a. m. Ci.-St., from the west, increased from 2/10 to 8/10. The head kite was in St.-Cu., altitude 1,200 m., from 9.10 to 9.21 a. m. A solar halo was visible after 11.10 a. m.

High pressure (776 mm.) was central over New Jersey. Low pressure (758 mm.) was central over southern Texas.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Mar. 24, 1912:	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%		*m. p. s.*
3.51 p. m....	703.6	1.6	100	se.	4.9	526	703.6	1.6	100	se.	4.9
3.59 p. m....	703.5	1.8	100	se.	5.8	745	684.9	5.2	100	s.	9.9
4.44 p. m....	703.2	2.2	100	se.	7.6	1,216	646.6	10.4	83	ssw.	13.3
4.55 p. m....	703.1	2.4	100	se.	7.2	1,589	618.2	8.9	88	sw.	13.6
5.15 p. m....	703.0	2.5	100	se.	5.4	2,181	575.2	4.2	98	wsw.	18.1
5.19 p. m....	703.0	2.4	100	se.	3.6	2,244	570.8	4.0	88	wsw.	28.1
5.20 p. m....	703.0	2.5	100	e.	3.6	2,307	566.2	3.7	90	wsw.	34.1
5.21 p. m....	703.0	2.5	100	e.	3.6	2,241	570.8	4.2	86	wsw.	22.1
5.25 p. m....	703.0	2.6	100	ne.	2.7	2,145	577.6	4.2	94	wsw.	26.0
5.37 p. m....	703.0	2.8	100	se.	1.8	1,401	632.4	8.0	96	ssw.	14.2
5.48 p. m....	702.9	2.8	100	ne.	1.8	928	669.3	10.0	94	s.	15.5
5.52 p. m....	702.9	2.8	100	ne.	1.8	526	702.9	2.8	100	ne.	1.8
Mar. 25, 1912:											
9.01 a. m...	710.7	−2.6	78	nw.	12.1	526	710.7	− 2.6	78	nw.	12.1
9.10 a. m...	710.8	−2.6	78	nw.	13.0	958	672.8	− 6.0	80	nnw.	18.9
9.31 a. m...	710.9	−2.1	77	nw.	13.0	1,230	650.1	− 4.8	44	nnw.	18.4
9.38 a. m...	710.9	−2.0	77	nw.	14.3	1,625	618.2	− 5.4	37	nnw.	18.9
10.31 a. m...	711.3	−1.1	71	nw.	13.4	1,631	618.2	− 3.2	23	nnw.	10.8
11.05 a. m...	711.6	−0.3	67	nw.	13.0	2.029	588.0	− 6.2	21	nnw.	11.6
11.12 a. m...	711.7	−0.1	68	nw.	13.0	2.278	569.7	− 8.1	21	nnw.	8.5
11.21 a. m...	711.7	0.1	69	nw.	11.6	3,592	479.8	−14.2	21	nw.	16.3
11.30 a. m...	711.8	0.1	65	nw.	12.1	3,376	493.4	−13.4	27	nw.	19.9
11.40 a. m...	711.8	0.2	60	nw.	13.0	2,810	531.1	−11.7	28	nw.	12.5
11.50 a. m...	711.8	0.4	60	nw.	13.0	2,375	561.9	− 9.7	28	nw.	15.3
12.01 p. m...	711.9	0.8	61	nw.	12.5	1,593	621.7	− 6.8	26	nnw.	15.5
12.17 p. m...	711.9	1.2	68	nw.	11.2	1,417	635.9	− 8.4	37	nw.	21.5
12.26 p. m...	711.9	1.3	68	nw.	10.7	990	671.6	− 4.9	61	nw.	15.5
12.37 p. m...	711.9	2.0	71	nw.	11.6	526	711.9	2.0	71	nw.	11.6
Mar. 26, 1912:											
8.12 a. m...	717.5	−0.4	73	sse.	8.9	526	717.5	− 0.4	73	sse.	8.9
8.21 a. m...	717.5	−0.2	72	sse.	9.8	927	682.4	− 2.7	68	sw.	14.2
8.33 a. m...	717.4	0.2	67	sse.	8.9	1,496	634.8	− 4.8	67	wsw.	16.8
8.49 a. m...	717.4	0.4	68	sse.	8.0	2,248	576.8	− 7.6	55	w.	19.8
9.06 a. m...	717.3	0.7	67	sse.	7.6	2,910	529.5	− 8.8	67	w.	25.3
9.33 a. m...	717.1	1.2	72	sse.	9.8	3,371	498.9	−11.7	77	w.	33.3
10.15 a. m...	716.8	3.2	58	sse.	8.9	3,824	470.3	−12.8	68	wnw.	37.9
10.52 a. m...	716.2	4.2	57	s.	11.6	3,215	508.8	−11.2	73	w.	29.2
11.10 a. m...	716.1	5.0	62	sse.	11.6	2,506	557.7	− 7.3	74	w.	20.6
11.34 a. m...	715.9	4.6	61	sse.	10.3	1,576	....	− 3.9	48	wsw.	18.9
11.48 a. m...	715.9	5.4	62	se.	9.8	956	678.8	− 1.7	73	ssw.	13.6
11.56 a. m...	715.8	5.0	62	se.	9.8	526	715.8	5.0	62	se.	9.8

March 24, 1912.—Three kites were used; lifting surface, 20.9 sq. m. Wire out, 3,000 m.; at maximum altitude, 2,700 m.

There was dense fog.

Low pressure (751 mm.), central over Kentucky, covered the eastern United States.

March 25, 1912.—Six kites were used; lifting surface, 35.0 sq. m. Wire out, 7,200 m.; at maximum altitude, 5,600 m.

There were 4/10 to 1/10 Ci. and a few to 4/10 St.-Cu., all from the northwest.

Low pressure (744 mm.) was central over Nova Scotia and high pressure (769 mm.) over Texas.

March 26, 1912.—Six kites were used; lifting surface, 37.8 sq. m. Wire out, 7,500 m.; at maximum altitude, 6,300 m.

Ci.-St., from the west, decreased from 5/10 to 1/10. After 11.10 a. m. there was also 1/10 St.-Cu. from the southwest.

High pressure (769 mm.) was central over the middle Atlantic coast. Low pressure (756 mm.) was central over Lake Superior.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Mar. 27, 1912:	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%		*m. p. s.*
8.12 a. m...	717.0	4.3	75	nw.	5.4	526	717.0	4.3	75	nw.	5.4
8.26 a. m...	717.0	4.7	75	nw.	4.9	799	693.4	4.4	73	wnw.	10.9
8.36 a. m...	717.1	5.1	74	nw.	4.9	1,439	640.9	0.7	73	wsw.	18.5
8.47 a. m...	717.1	5.3	73	nw.	6.7	1,969	599.8	− 2.0	57	w.	31.8
8.55 a. m...	717.1	5.6	73	nw.	5.4	2,342	572.3	− 3.7	52	w.	25.8
8.57 a. m...	717.1	5.6	72	nw.	5.4	2,436	565.5	− 3.1	47	w.	21.9
9.30 a. m...	717.0	6.1	70	nw.	5.4	2,762	542.3	− 4.8	27	w.	18.7
10.22 a. m...	717.0	7.9	64	wnw.	2.7	2,356	571.1	− 2.9	19	w.	23.1
10.24 a. m...	717.0	8.0	65	wnw.	2.7	2,213	581.3	− 3.4	15	w.	26.6
10.27 a. m...	717.0	8.0	65	wnw.	2.7	2,103	589.4	− 2.9	15	w.	26.6
10.32 a. m...	716.9	8.5	64	w.	3.6	1,967	599.8	− 3.7	23	w.	31.0
10.46 a. m...	716.9	9.3	62	w.	4.0	1,424	642.1	0.4	61	w.	20.6
11.00 a. m...	716.9	9.7	59	wsw.	4.0	773	695.8	6.1	62	sw.	10.8
11.04 a. m...	716.9	10.2	59	wsw.	4.0	526	716.9	10.2	59	wsw.	4.0
Mar. 28, 1912:											
12.52 p. m...	714.8	10.4	70	se.	7.6	526	714.8	10.4	70	se.	7.6
12.55 p. m...	714.7	10.4	71	se.	....	662	703.1	9.3	67	sse.	11.6
1.07 p. m...	714.6	10.4	73	se.	6.7	966	677.9	12.2	44	ssw.	17.6
1.18 p. m...	714.5	10.7	70	se.	7.2	1,099	667.2	11.4	44	ssw.	14.0
1.28 p. m...	714.3	10.6	71	se.	7.2	1,601	628.0	7.2	52	ssw.	18.1
1.50 p. m...	714.1	10.4	71	se.	6.7	2,096	590.8	1.7	63	ssw.	20.7
2.01 p. m...	714.0	10.4	73	se.	6.7	2,281	577.2	− 0.2	72	ssw.	....
2.06 p. m...	713.9	10.4	73	se.	6.3	2,863	536.3	− 4.3	85	ssw.	26.7
2.18 p. m...	713.8	10.5	74	se.	6.3	2,680	548.3	− 3.3	85	ssw.	27.7
2.32 p. m...	713.6	10.6	74	se.	6.7	2,254	578.4	− 1.4	83	s.	23.9
2.44 p. m...	713.5	10.8	71	se.	6.7	1,618	625.7	5.4	65	s.	18.6
2.51 p. m...	713.4	10.7	72	se.	6.7	1,009	673.2	11.1	54	s.	10.3
....	....	10.7	72	se.	....	....	....	9.7	51	sse.	....
2.59 p. m...	713.3	10.6	74	se.	6.3	526	713.3	10.6	74	se.	6.3

March 27, 1912.—Five kites were used; lifting surface, 33.5 sq. m. Wire out, 5,500 m.; at maximum altitude, 4,800 m.

There were a few St.-Cu., from the west-northwest, until 8.55 a. m. Ci.-St., from the west, appeared about 9.20 a. m., and increased to 7/10. Solar halo visible after 10.15 a. m. Light haze all day.

High pressure (767 mm.) was central over Georgia and low pressure (752 mm.) north of Lake Superior.

March 28, 1912.—Four kites were used; lifting surface, 25.7 sq. m. Wire out, 4,000 m., at maximum altitude.

The sky was covered with A.-St. and St.-Cu., both from the south-southwest. Light rain fell after 1.59 p. m.

High pressure was central over Pennsylvania (765 mm.), and low pressure over Louisiana (750 mm.).

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind. Direction.	Wind. Velocity.	Height.	Pressure.	Temperature.	Rel. hum.	Wind. Direction.	Wind. Velocity.
Mar. 29, 1912:											
First flight—	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%		*m. p. s.*
9.57 a. m...	700.2	10.4	100	sse.	8.0	526	700.2	10.4	100	sse.	8.0
10.03 a. m...	700.2	10.8	99	sse.	6.3	882	671.1	13.8	76	ssw.	16.2
10.10 a. m...	700.1	11.2	98	sse.	6.3	1,018	660.3	12.7	75	sw.	18.1
10.22 a. m...	700.0	12.0	93	sse.	6.7	1,546	619.9	8.2	79	sw.	23.7
10.30 a. m...	700.0	12.5	93	sse.	6.7	2,008	586.0	4.8	75	sw.	24.1
10.59 a. m...	699.7	14.0	85	sse.	7.2	526	699.7	14.0	85	sse.	7.2
Second flight—											
11.19 a. m...	699.7	15.2	84	sse.	7.2	526	699.7	15.2	84	sse.	7.2
11.30 a. m...	699.7	15.8	79	ssc.	7.2	977	663.3	12.2	77	sw.	16.3
11.44 a. m...	699.6	15.8	81	ssw.	7.2	1,377	632.4	9.0	82	sw.	16.3
12.10 p. m...	699.6	16.8	77	ssw.	5.8	1,914	592.3	4.7	78	wsw.	20.6
12.43 p. m...	699.8	16.2	79	ssw.	5.8	2,844	528.0	− 1.8	84	w.	27.5
1.26 p. m...	700.0	18.4	56	wsw.	9.8	3,393	492.4	− 6.5	73	w.	29.2
1.49 p. m...	700.1	18.6	53	wsw.	9.8	2,906	523.7	− 4.6	88	w.	31.8
2.03 p. m...	700.1	17.6	55	wsw.	9.4	2,535	549.0	− 2.5	100	w.	23.1
2.14 p. m...	700.2	17.6	54	w.	7.2	2,212	571.6	1.7	88	w.	21.5
2.22 p. m...	700.2	17.8	54	w.	6.7	1,716	607.5	5.6	82	w.	14.6
2.26 p. m...	700.3	17.8	54	w.	6.3	1,248	643.0	10.1	74	w.	9.1
2.39 p. m...	700.4	17.0	54	w.	8.5	526	700.4	17.0	54	w.	8.5
Mar. 30, 1912:											
8.07 a. m...	718.2	2.6	81	nw.	13.4	526	718.2	2.6	81	nw.	13.4
8.12 a. m...	718.2	2.6	80	nw.	13.4	783	695.7	0.6	78	nnw.	8.2
9.16 a. m...	718.9	3.2	76	nw.	9.4	975	680.1	4.7	43	n.	9.7
9.20 a. m...	718.9	3.4	77	nw.	9.4	792	695.7	1.2	52	n.	13.3
9.29 a. m...	719.1	3.5	74	nw.	8.9	526	719.1	3.5	74	nw.	8.9
Mar. 31, 1912:											
8.05 a. m...	720.8	6.8	67	wnw.	8.9	526	720.8	6.8	67	wnw.	8.9
8.13 a. m...	720.8	6.8	67	wnw.	9.8	814	695.9	4.6	54	wnw.	13.8
8.15 a. m...	720.8	6.8	66	wnw.	9.8	884	689.9	4.0	51	wnw.	22.3
8.35 a. m...	720.9	7.6	63	wnw.	9.8	1,349	651.8	5.4	23	nw.	8.2
9.20 a. m...	720.8	9.0	51	wnw.	11.2	1,442	644.6	5.3	12	nw.	6.4
9.35 a. m...	720.8	9.4	53	wnw.	13.9	2,056	597.8	2.1	10	wnw.	10.7
9.51 a. m...	720.7	9.6	54	wnw.	15.6	3,201	518.0	− 2.8	10	wnw.	17.2
10.02 a. m...	720.7	9.8	55	wnw.	11.6	3,477	500.2	− 5.1	10	wnw.	19.1
10.13 a. m...	720.7	10.6	54	wnw.	11.6	3,046	528.3	− 3.2	10	wnw.	19.8
10.24 a. m...	720.7	10.6	49	wnw.	10.3	2,432	570.6	− 0.3	10	wnw.	16.8
10.35 a. m...	720.6	10.8	50	wnw.	8.5	1,793	617.6	2.2	10	wnw.	6.0
10.51 a. m...	720.6	11.6	48	wnw.	6.3	1,251	660.0	8.4	10	wnw.	8.8
11.02 a. m...	720.6	11.7	45	wnw.	7.6	1,236	661.2	4.9	17	wnw.	9.4
11.10 a. m...	720.5	11.9	44	wnw.	7.6	745	701.9	7.8	32	wnw.	9.4
11.16 a. m...	720.5	11.6	45	wnw.	5.4	526	720.5	11.6	45	wnw.	5.4

March 29, 1912.—First flight: Two kites were used; lifting surface, 12.6 sq. m. Wire out, 2,200 m., at maximum altitude.

There was dense fog until 10.10 a. m. Thereafter A.-Cu. from the southwest and St. from the south-southeast decreased from 4/10 to 2/10.

Second flight: Five kites were used; lifting surface, 28.6 sq. m. Wire out, 6,200 m.; at maximum altitude, 5,600 m.

Cu. from the southwest and St.-Cu. from the south increased from 2/10 to 7/10 before 12.40 p. m. Thereafter Cu. from the west increased from 5/10 to 9/10. Light rain fell from 12.43 to 1.00 p. m. and after 2.39 p. m. The head kite was in Cu. at 12.43 p. m. and from 1.55 to 2.03 p. m. Altitude of base, about 2,500 m.

Low pressure (745 mm.) central over Ohio covered the eastern United States.

March 30, 1912.—Five kites were used; lifting surface, 30.6 sq. m. Wire out, 3,200 m.; at maximum altitude, 900 m.

The sky was cloudless throughout the flight.

High pressure was central over Lake Huron (770 mm.) and low pressure was central over Nova Scotia (748 mm.).

March 31, 1912.—Seven kites were used; lifting surface, 46.1 sq. m. Wire out, 6,800 m.; at maximum altitude, 6,200 m.

The sky was cloudless.

High pressure (771 mm.) was central over West Virginia. Low pressure (761 mm.) covered the Province of Quebec.

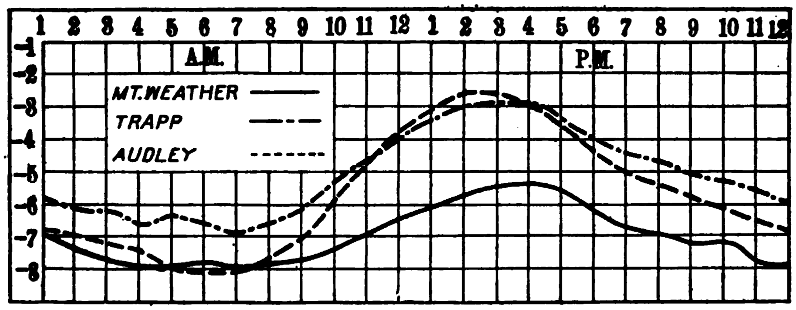

FIG. 1.—Mean hourly temperatures for January, 1912.

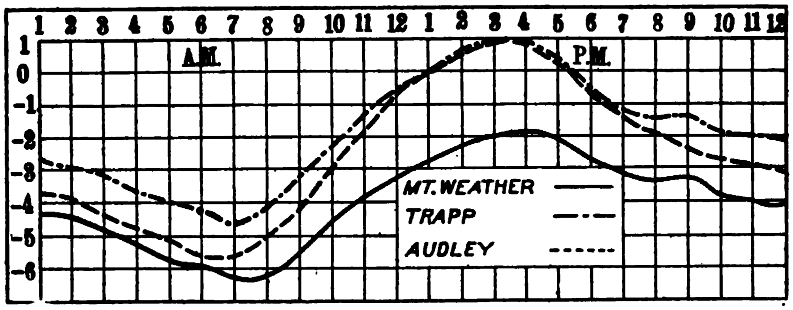

FIG. 2.—Mean hourly temperatures for February, 1912.

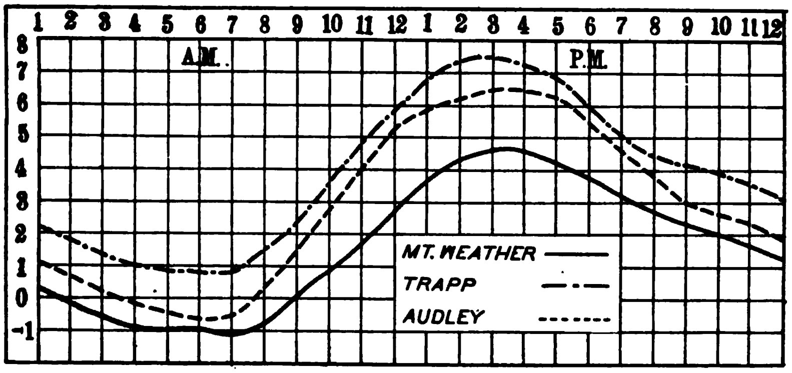

FIG. 3.—Mean hourly temperatures for March, 1912.

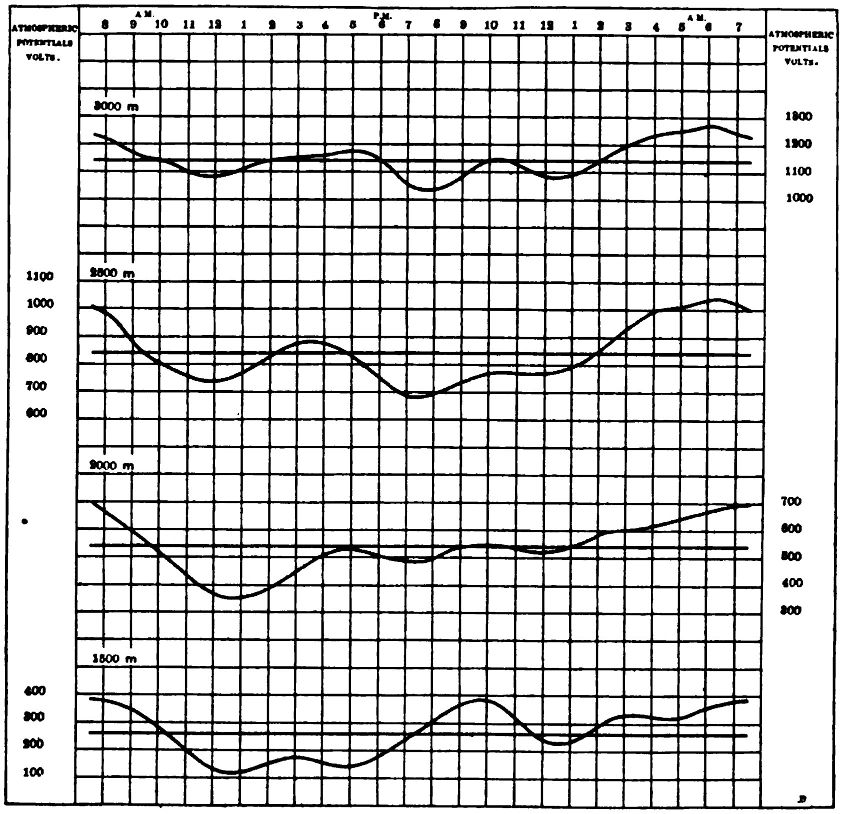

FIG. 4.—Atmospheric electric potentials at Mount Weather, August 16-17, and September 12-13, 1911.

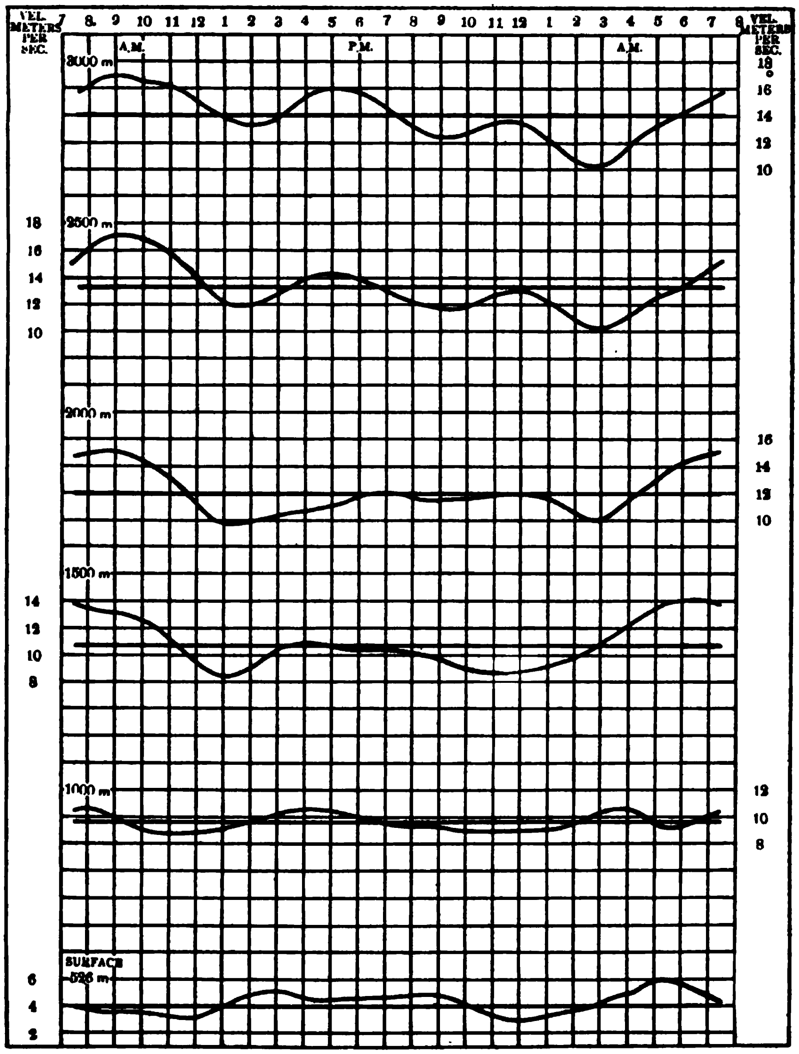

FIG. 5.—North Component—Wind observations at Mount Weather, August 16–17 and September 12–13, 1911.

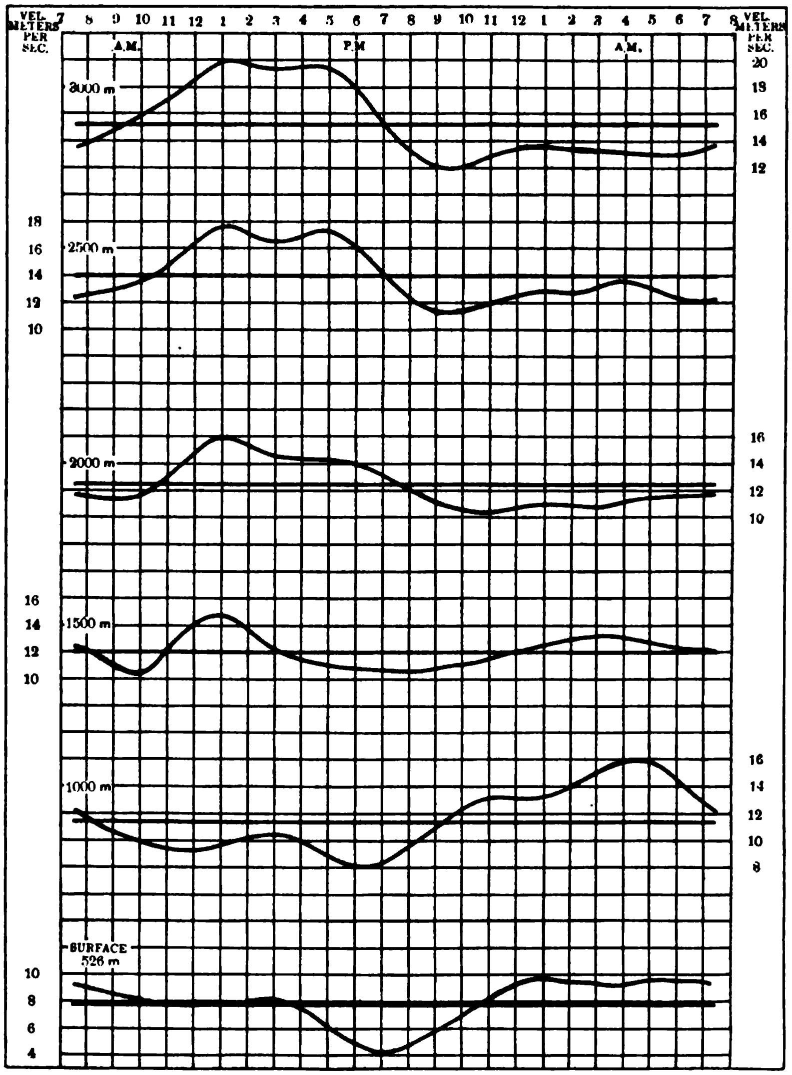

FIG. 6.—West Component—Wind observations at Mount Weather, August 16–17 and September 12–13, 1911.

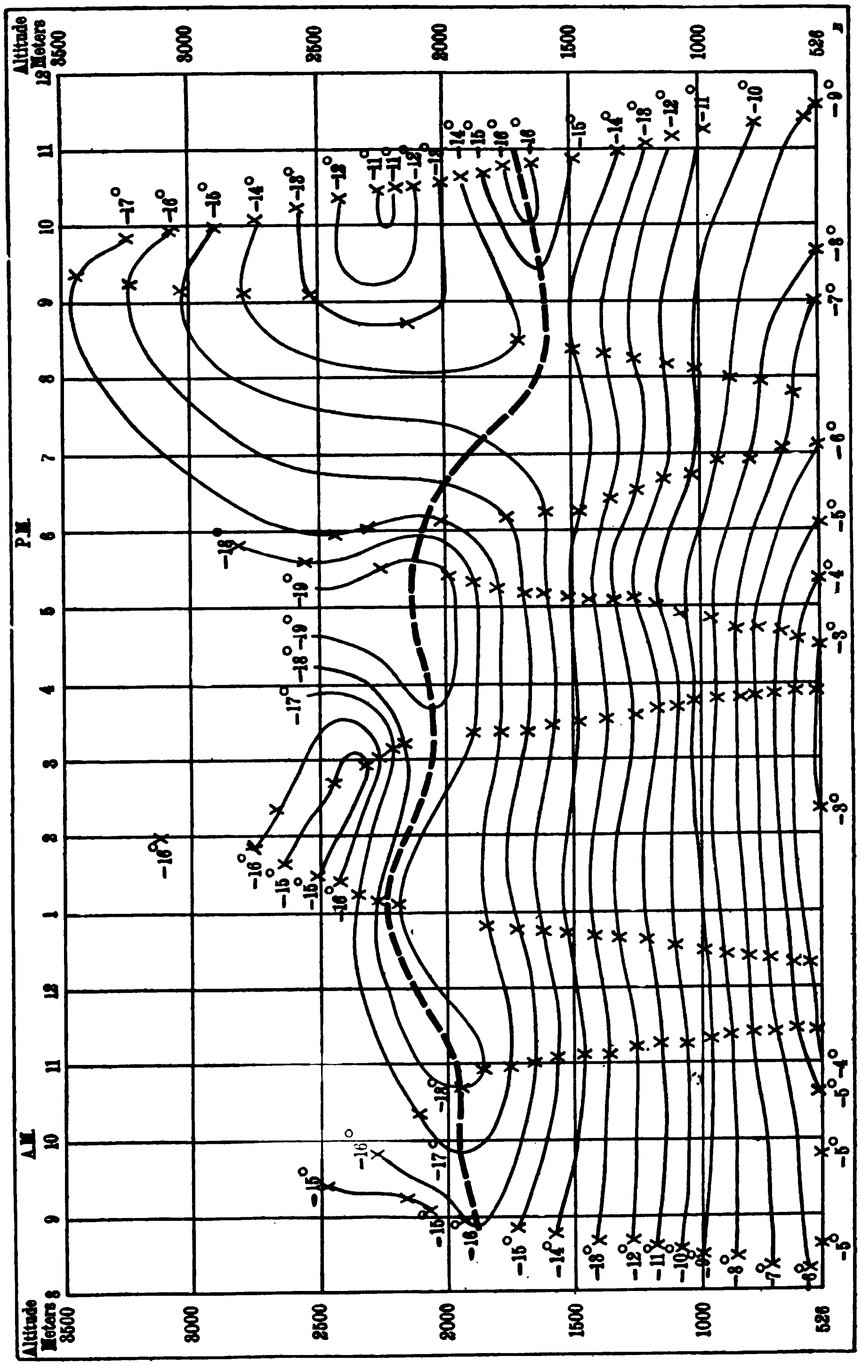

FIG. 7.—Free air isotherms above Mount Weather, February 8, 1912.

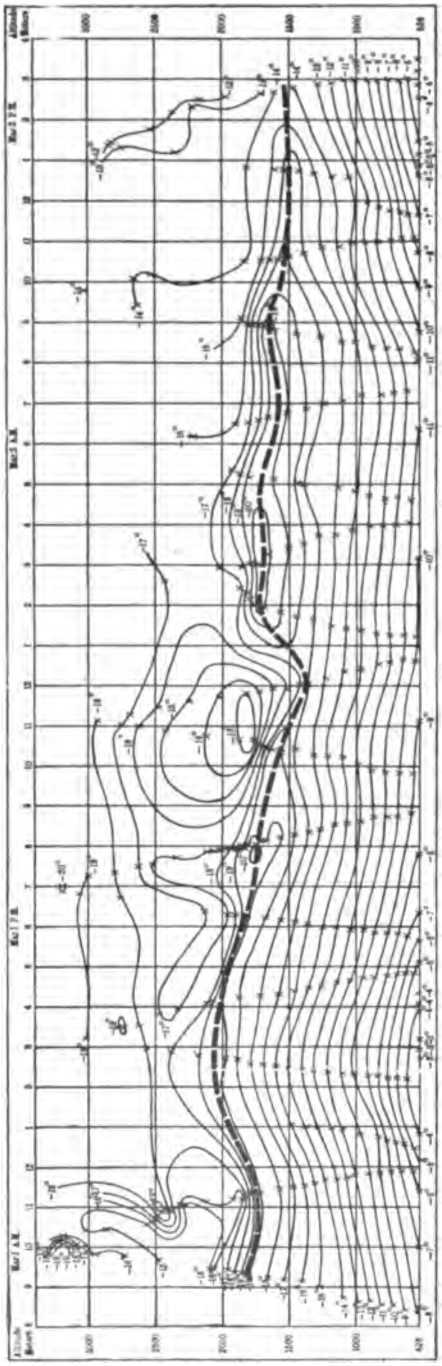

FIG. 8.—Free air isotherms above Mount Weather, March 1-2, 1912.

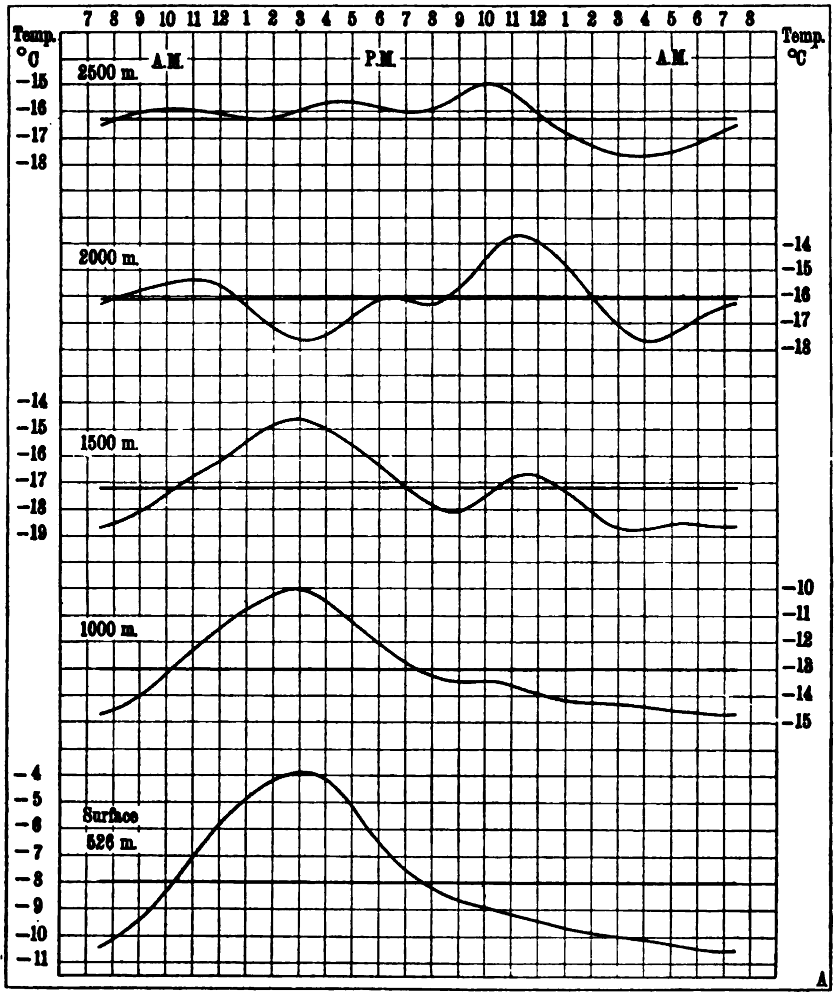

FIG. 9.—Free air temperatures at different levels above Mount Weather, March 1–2, 1912.

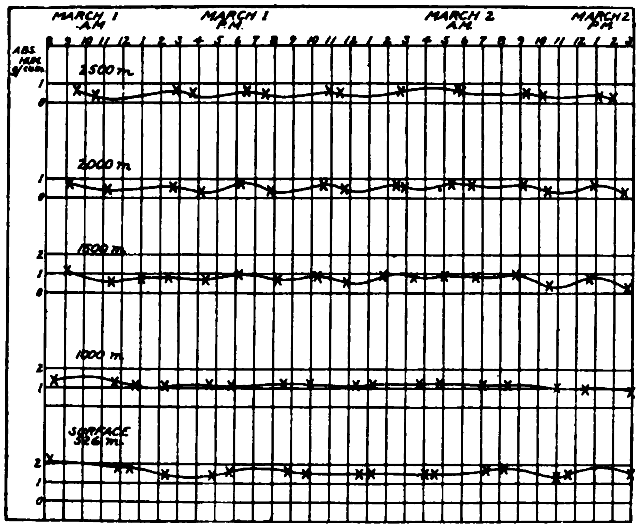

FIG. 10.—Absolute humidity at different levels above Mount Weather, March 1–2, 1912.

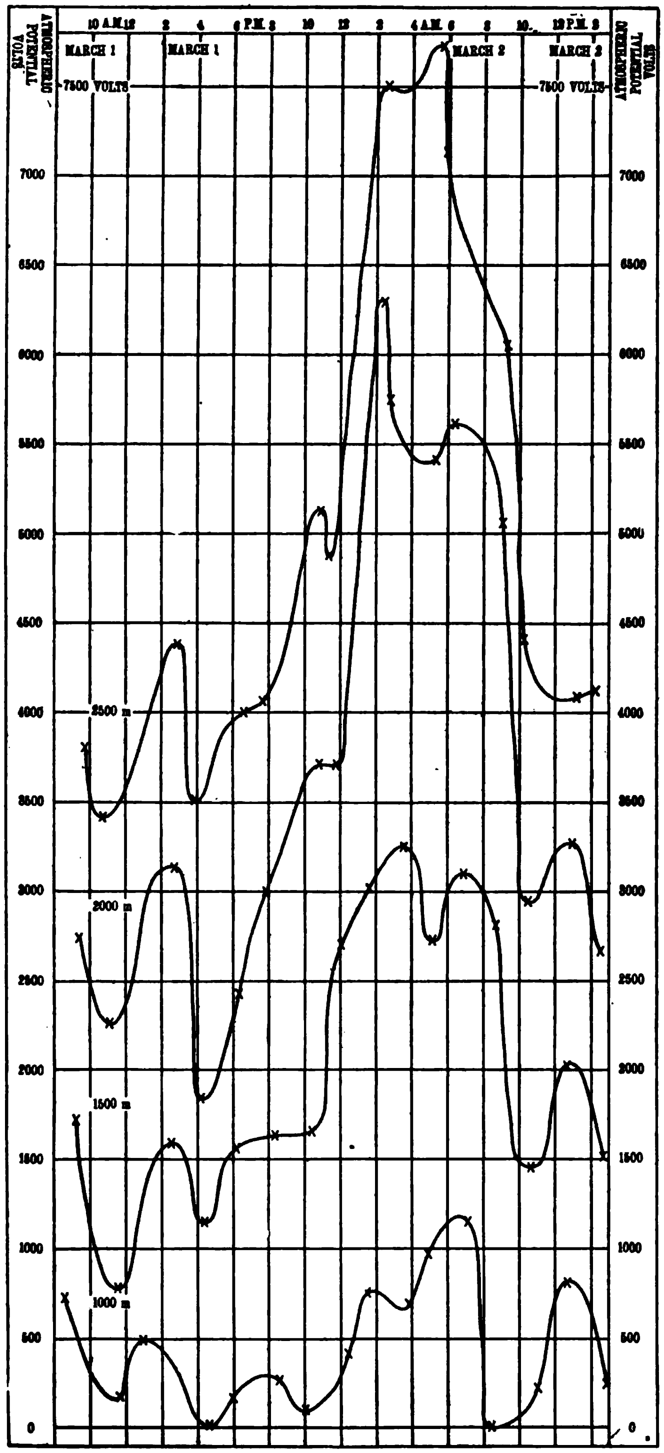

FIG. 11.—Atmospheric electric potentials observed at Mount Weather, March 1–2, 1912.

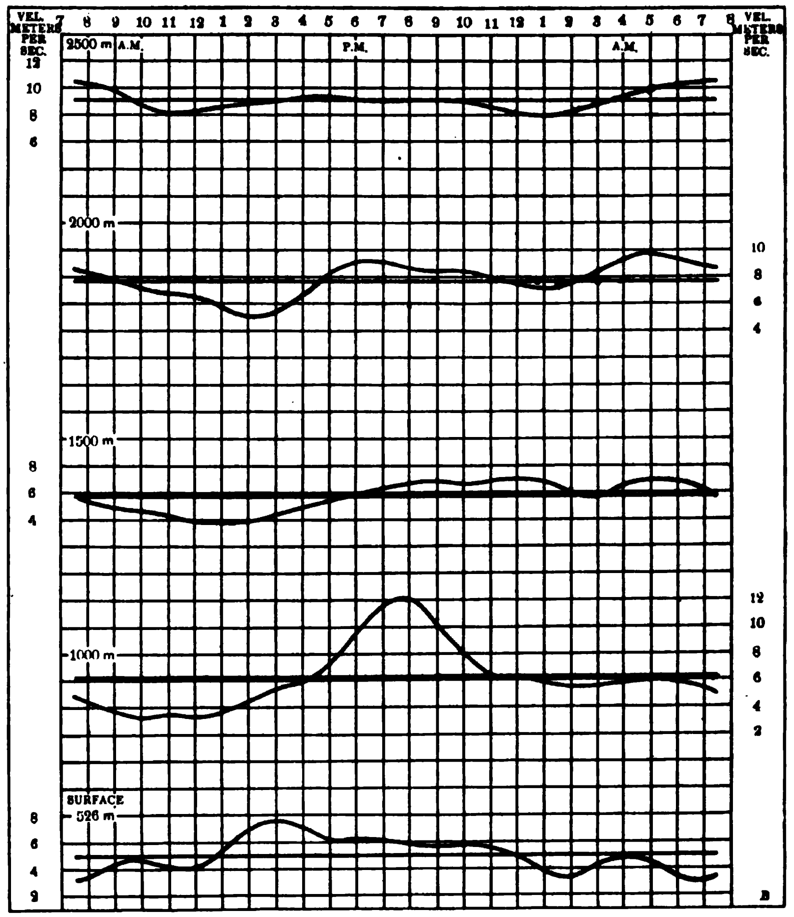

FIG. 12.—North Component—Wind observations at Mount Weather, March 1–2, 1912.

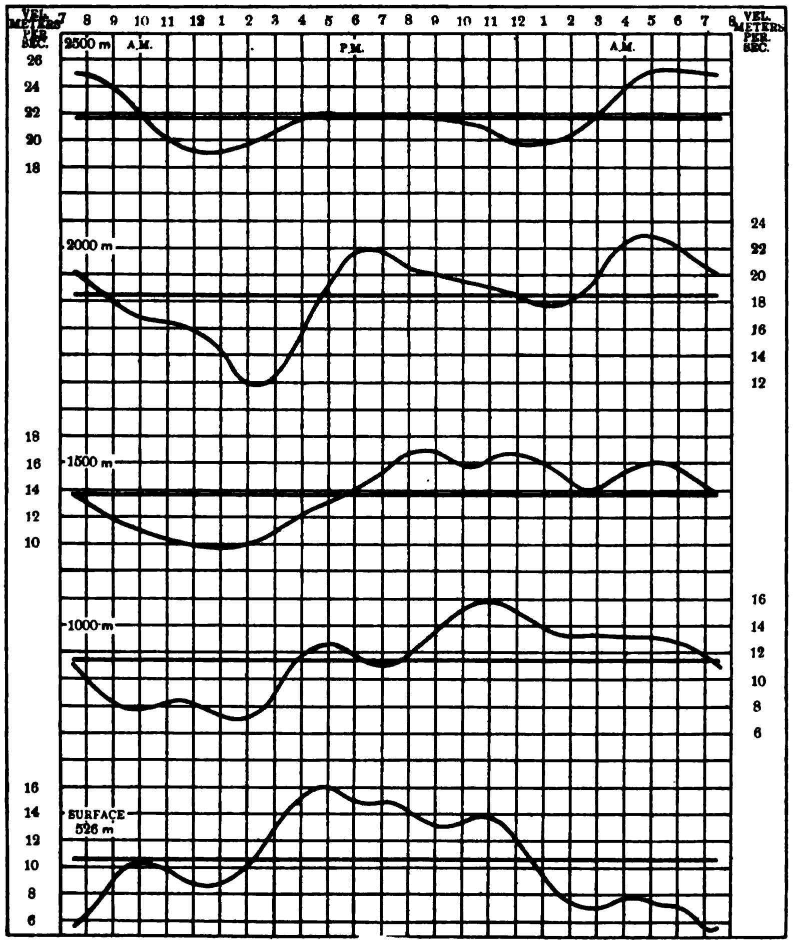

FIG. 13.—West Component—Wind observations at Mount Weather, March 1–2, 1912.

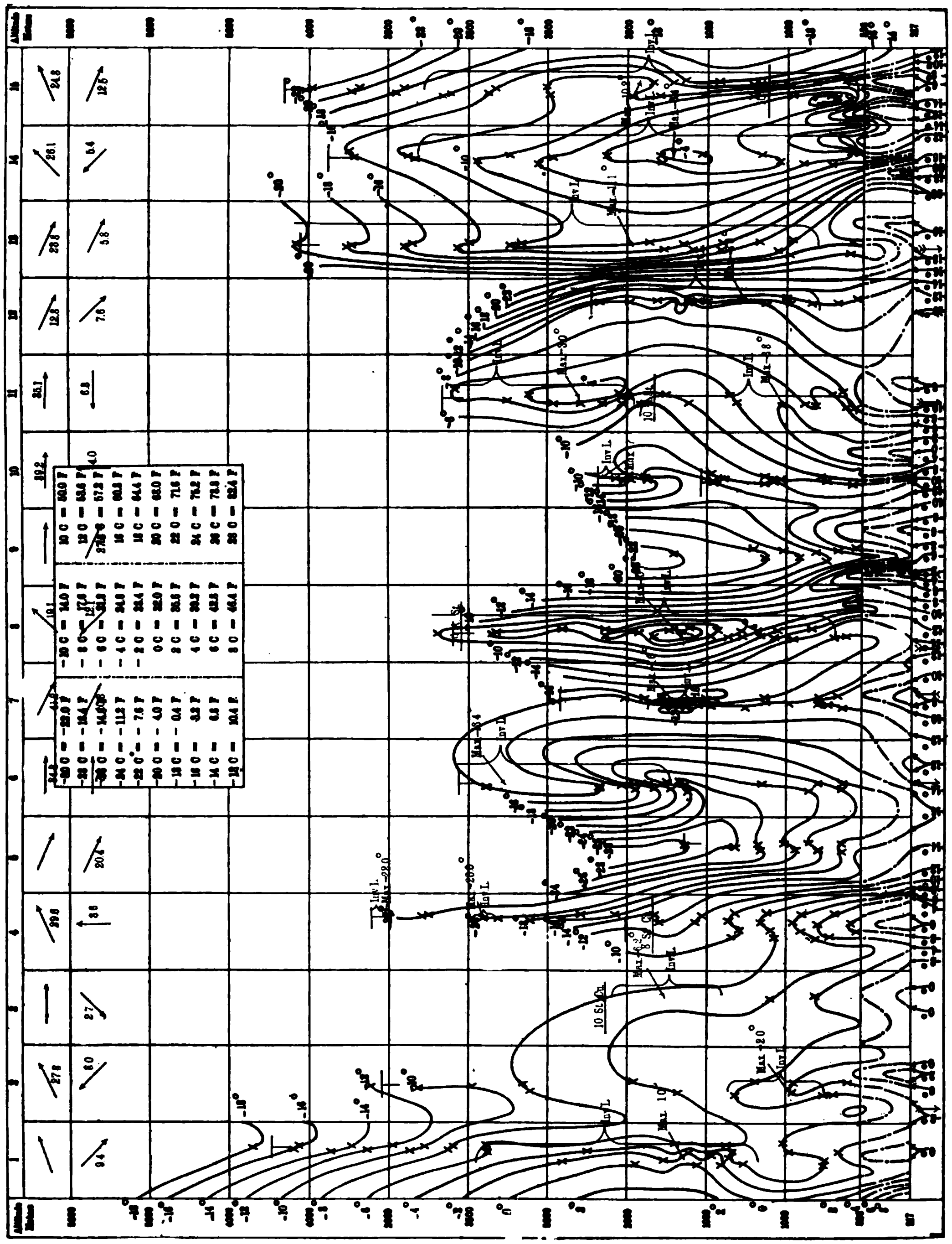

CHART I.—Free air isotherms, January 1–15, 1912.

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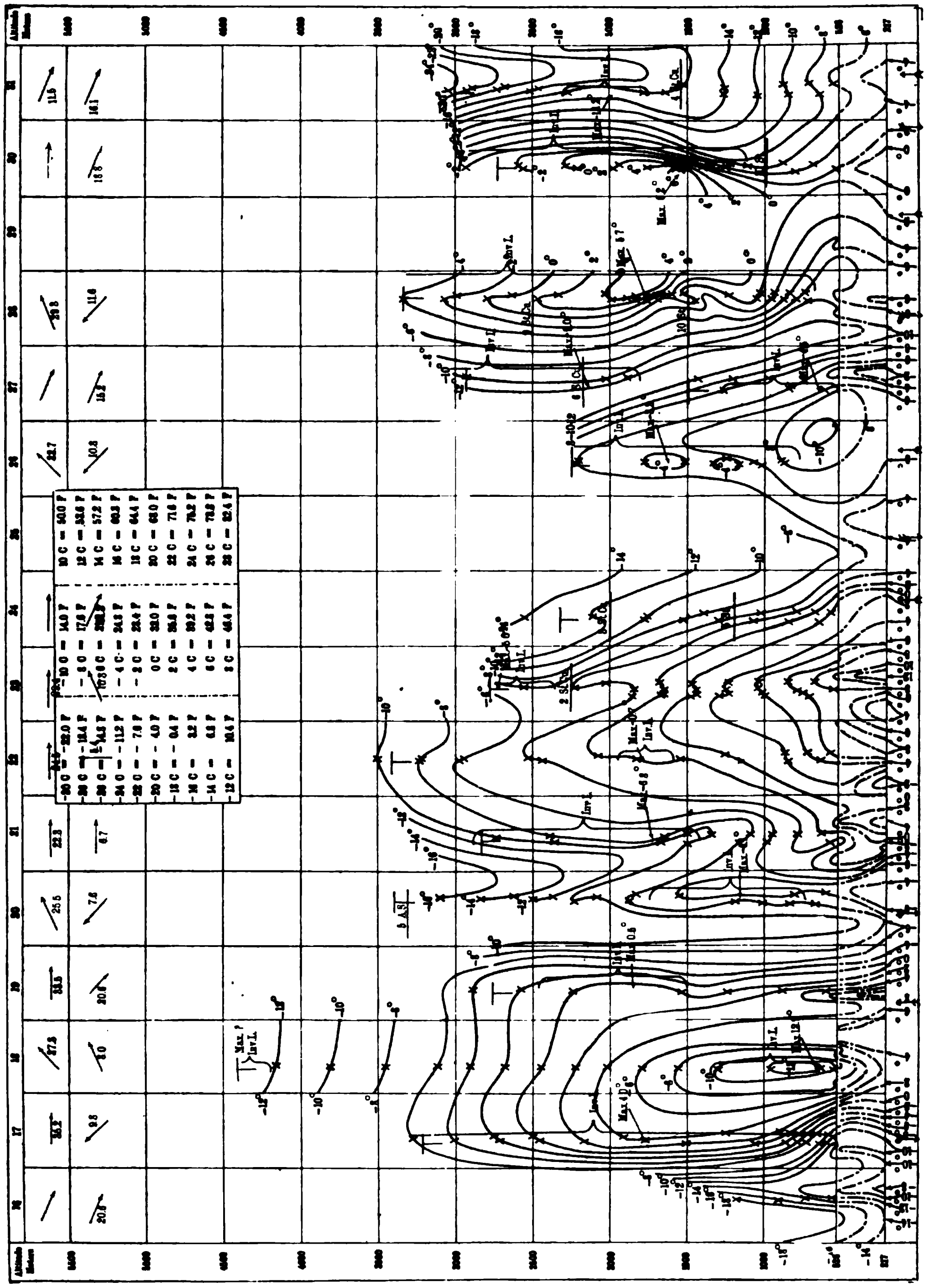

CHART II.—Free air isotherms, January 16–31, 1912.

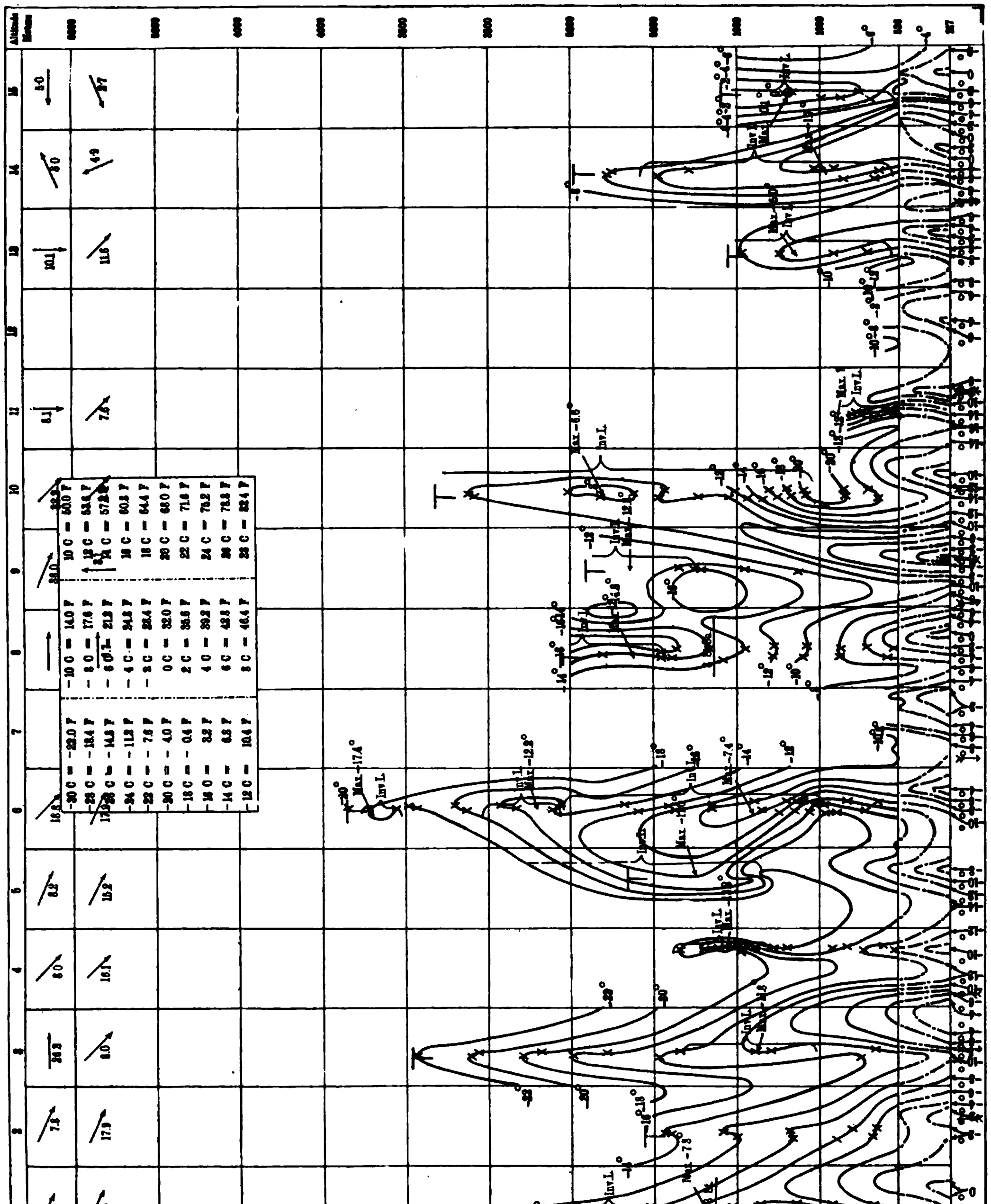

CHART III.—Free air isotherms, February 1-15, 1912.

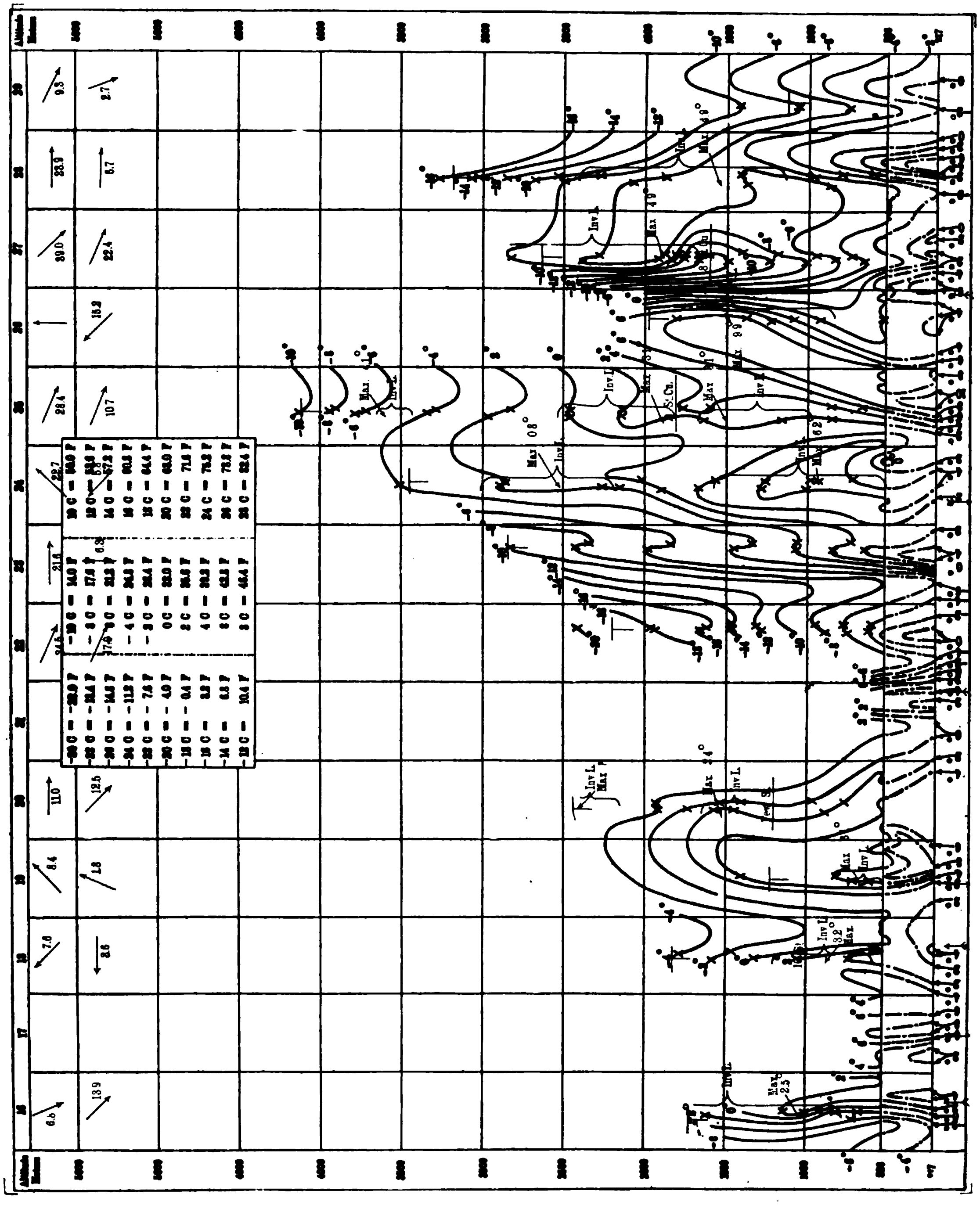

CHART IV.—Free air isotherms, February 16–29, 1912.

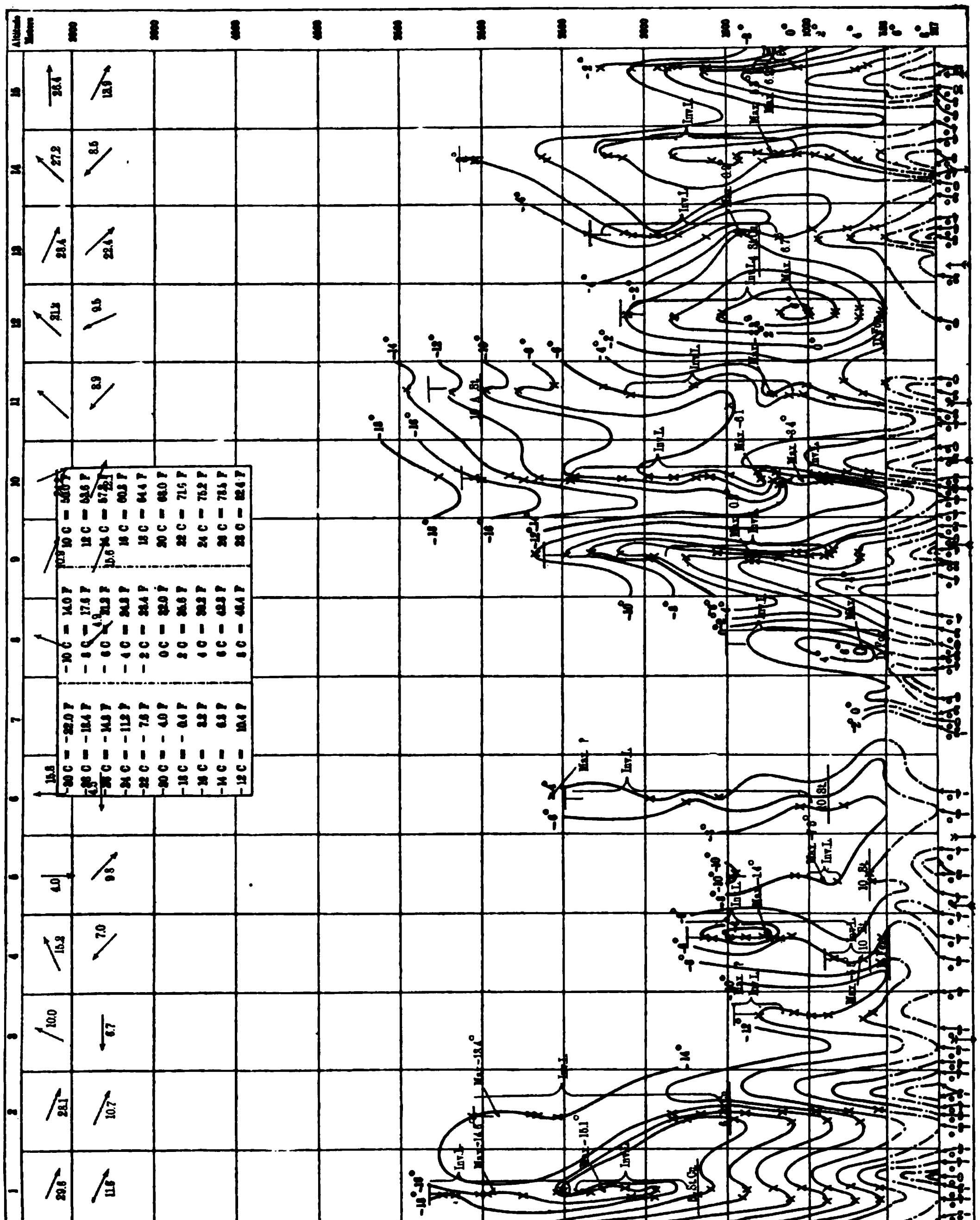

Chart V.—Free air isotherms, March 1–15, 1912.

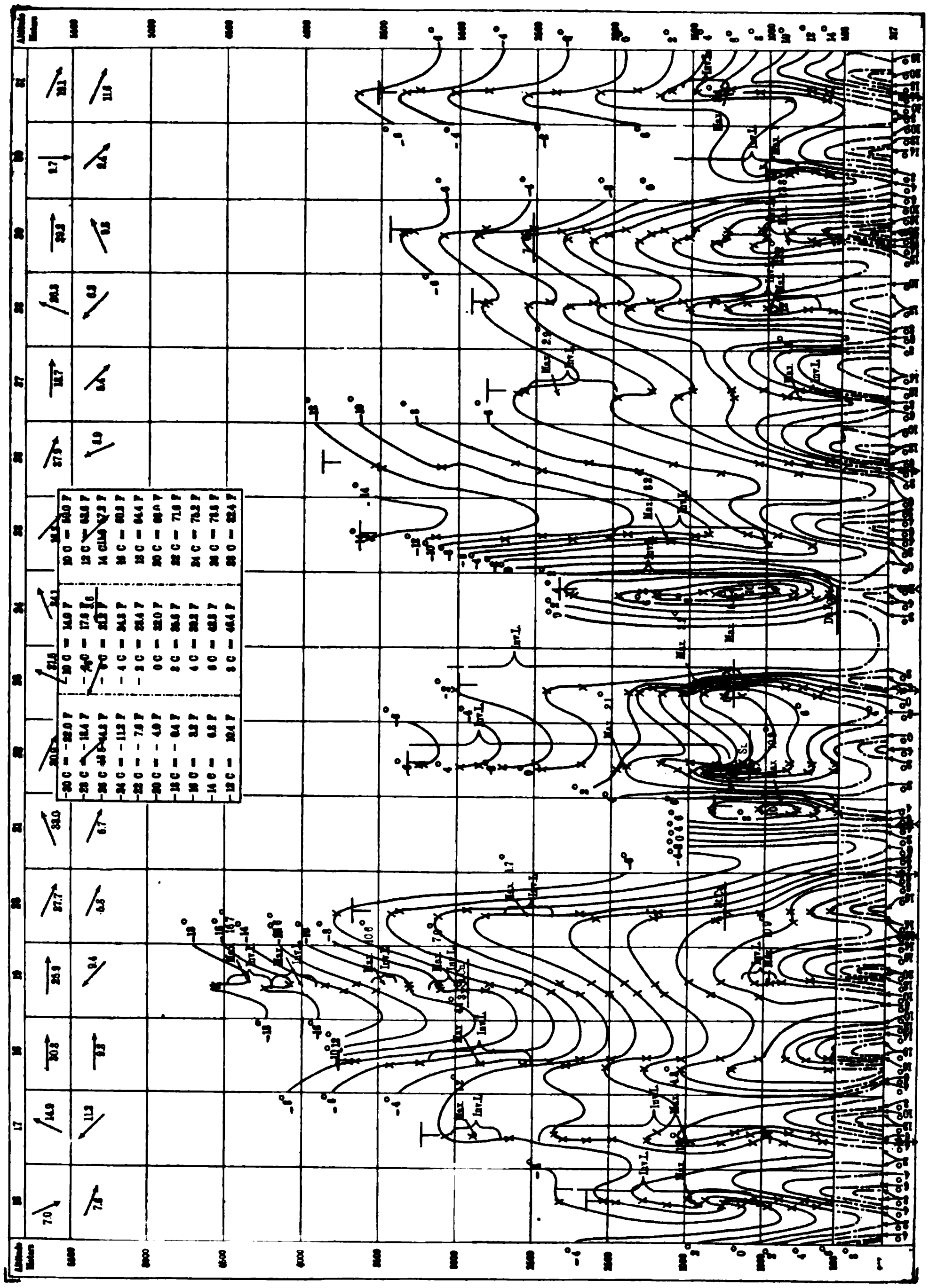

CHART VI.—Free air isotherms, March 16–31, 1912.

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BULLETIN

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W. B. No. 492.	CLEVELAND ABBE, Editor.	Issued November 15, 1912.

(III) ATMOSPHERIC STUDIES.

By J. W. Sandström.

In publishing this work the Chief of Bureau recognizes with pleasure the privilege thus conferred by Mr. Sandström and the diligent labor of Dr. C. Abbe, jr., as translator. The manuscripts of these five important articles by Sandström were communicated to the editor from time to time as shown by the appended dates in the expectation that the English version would appear at Washington simultaneously with the Swedish originals at Stockholm. It is hoped that the slight delay has improved the character of the translation. The editor has adopted the arrangement of the text and illustrations recommended by the author, but modified to agree with his "Energie umwandlungen," of September, 1911, and his "Wirbel bewegungen," of November 8, 1911. He also distinguishes between the ideal vortex filaments of Helmholtz and the natural vortex threads that Sandström considers existent in the viscous atmospheric air.—C. A.

Chapter 1.—Air Movements in the Mountains of Sweden.[1]

§ (1).

Every person who makes a ski trip through the upper levels of Sweden's mountains soon learns to judge of the direction and intensity of the latest gale from the appearance of the snow surface. This experience can advantageously be applied in studying the air movements in the mountains, and this I have done.

The first conclusion from such studies is that the wind is directly related to the topography, for it is apparent that the strong, violent winds always blow down, and never up, the slopes. I could verify this fact by direct observations whenever I was overtaken by mountain storms during my field studies. So long as I remained on the windward slope of the mountain the wind was relatively weak. Just as soon as I passed over to the leeward slope the wind became

[1] Dated Stockholm, Sept. 7, 1911.

a hurricane. Figure 1 presents the characteristic appearance of the snow cover on the leeward slope of a mountain after the passage of a snowstorm.

I soon clearly understood the cause of this phenomenon. The wind whirls along with it a great mass of loose snow which densely fills the air to a height of 20 to 50 meters. Dynamically, this densely snow-charged air is very heavy, since in calculating the specific gravity of the whole, one must also take account of the admixed snow. Consequently this mass of air moves up hill very unwillingly, but as soon as it reaches the crest and begins to descend its speed increases rapidly and the mass soon attains a very great velocity. It shoots downward like a waterfall.

Viewed from a distance the snow-charged air appears like mist. One may very readily observe the whole phenomenon when standing in a valley and looking sideways at the mountain above where the

FIG. 1.—Evidences of a snowstorm having blown down hill.

phenomenon is taking place. In figure 2a, by the dotted portion, is shown the usual appearance of such a snow haze (Russian, *poorga*). The arrows indicate the direction of movement of the air. The phenomenon develops unusual intensity at the steep terminal descent of a broad high plateau, the mountain profile being such as that shown in figure 2b. I have often heard the unearthly roar of such atmospheric avalanches while at a distance and have observed the fall of the greenish snow-filled air; at times, even, I have been overtaken by such a storm and instantly hurled downward with it into the valley, owing my life only to my sturdy bergstock and my trustworthy skis.

§ (2).

I have found the movements which accompany the disappearance of such storms particularly interesting. At this stage I have often observed a very pronounced periodicity in the weather phenomena.

I observed a very fine example of this periodicity on the 16th of January, 1911. A hurricane wind raged for about 10 minutes, during which time enormous masses of snow rushed down. Then the weather became fine with sunshine and calm, which also lasted 10 minutes; whereupon the hurricane wind set in again. The changes from hurricane to calm and vice versa took place very rapidly, requiring but a very few minutes. A complete period of such weather changes embraced almost exactly 25 minutes. This peculiar kind of local weather phenomena continued throughout the whole day, and during this time the duration of the individual periods continued to be between 20 and 30 minutes.

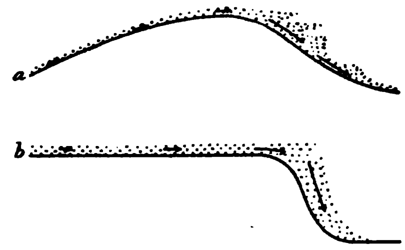

FIG. 2.—Wind phenomena in mountain snowstorms.

The cause of this peculiar periodicity of the weather seems to me to be as follows:

The plain below, at the foot of the mountain (see Fig. 3), is flooded with air of great density or specific gravity, and this stratum of dense air extends rather far up the mountain slope. Upon this air rests a layer of light air, the stratification being as shown in figure 3a. Now, when air made heavy by the load of snow that permeates it begins to rush down the mountain side, then the heavy horizontal stratum over the plain is pushed away by the descending cascade and is made to assume some such position as that indicated in figure 3b. But as the heavy descending air comes to rest in the valley its load of snow gradually settles to the ground, whereby the specific gravity of that air decreases considerably, and now becoming thus lighter, the unburdened air ascends. The displaced heavy air now rushes back and dashes up against the rocky slopes, as indicated in figure 3c. However, the cascade of snow-charged air continues, the rebounding valley air is again pushed back, and the whole game is repeated unceasingly. In this way waves several hundred meters high are set up in the region of discontinuity between the dense and the light air, as shown in figure 3d, and these waves, which bring about the periodicity in the weather, may be propagated to

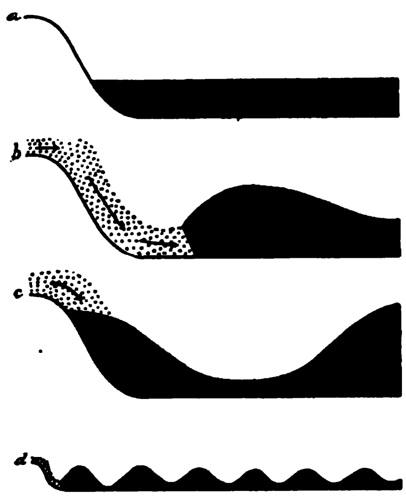

FIG. 3.—Origin of an atmospheric undulation.

considerable distances. By the aid of this wave mechanism the kinetic energy generated by the air avalanche may be spread over a very large region in the atmosphere.

Subsequently I was able to verify the fact that the periodic weather phenomena of January 16 did extend to a distance of 140 kilometers from my point of observation. Therefore on this occasion the atmospheric waves propagated themselves to this distance.[1]

§ (3).

In my notebook I find the following entry on February 9, 1911:

The black, compact, cloudy snowstorm stretches along the long crest of Barturte Tuoddar like a mighty stream. Everywhere else the sky is free of clouds so that the snowstorm stands out in beautiful relief. The very considerable speed of movement of the storm may be readily observed by means of the waves and other inequalities of its surface.

At the end of the long mountain crest the mighty mass of snow-filled air plunges down. (See fig. 4.) I see very clearly the resulting increase in the velocity of the air, and even at this distance of 12 kilometers I hear the roar as from a waterfall.

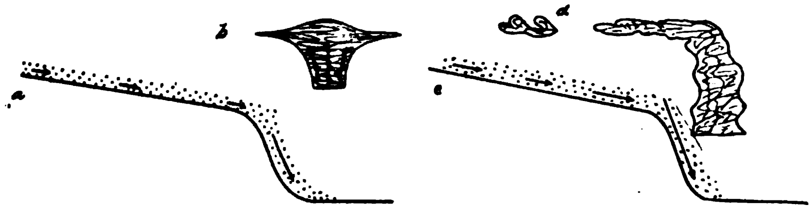

FIG. 4.—The cyclic process of the air in a mountain snowstorm.

Now a cloud forms above the declivity. It grows downward and gradually sinks so low that I can clearly distinguish the vertical movement within the cloud. Thus I get a good view of the whole circulation of the air as I represent it in figure 4. Evidently the air that produced this cloud had previously belonged to the snow storm, and now, after freeing itself of the snow mixed with it, it has become so light that it ascends to a high level. Being at first much lighter than the surrounding air, it rises rapidly. As the difference in specific gravity between it and the surrounding air gradually decreases, both the upward push and the vertical velocity decrease. Finally it reaches the level where it has the same specific gravity as the surrounding air, when it ceases to ascend and spreads out laterally. Evidently this level of equilibrium is the same as that at which the air mass was when it originally began to be charged with snow. The air has not itself undergone any physical change during its movement, but has simply been dragged down adiabatically and mechanically by the burden of snow. Therefore it returns to its original level as soon as it is freed from the load of snow.

§ (4).

I have made numerous observations of this kind on the processes that accompany the disappearance of the winds produced by the

[1] Similar illustrations of the great distance to which atmospheric waves may be traced are published in Am. Met. Jour. VII, 1891, p. 263, and VIII, p. 258; great waves traceable to long distances east of the Rocky Mountains will frequently be found recorded in America.—EDITOR.

mountain storms. All these observations have gradually led me to the conclusion that potential energy plays an important rôle in these cases.

By the annulment of the wind its kinetic energy (i. e., energy due to its motion) is transformed into heat. This transformation of energy requires the occupation of a very large volume of space, therefore the kinetic energy must necessarily be spread out through the whole mass. This is accomplished by the aid of potential energy, whether it takes place in the formation and propagation of waves or in some other way. A portion of the kinetic energy is by friction transformed directly into heat, the remaining energy of motion, which has no space for such transformation, is converted directly into potential energy. This latter sets the air at great distances into motion, and then the movement of this air is again by friction converted into heat.

Chapter 2.—On the Changes in Condition of Atmospheric Air.[1]

§ (5).

The hydrodynamic equations of motion and condition contain the laws of the course of the phenomena of atmospheric movements. A rational system of weather prediction must, then, be based upon these equations. Unfortunately they are too complicated to be directly applied in the ordinary course of a daily weather service. I have set myself the task of so far simplifying these equations that they may form the basis for the daily weather forecast.

This simplification must be accomplished in the following manner: The actual atmospheric movements occurring at a given time are to be observed; these are then compared with the solutions of the hydrodynamic equations. If the observed phenomena appear to be simpler than the solutions then the latter equations may be simplified and the manner in which this simplification may be accomplished will be indicated by the points of difference between the observed motions and the solution of the equations.

Of course this work will present many difficulties, and will demand the expenditure of much time; but the matter is of such importance that it is well worth the trouble it may cost. For a beginning I spent five months during the winter of 1910–11 in the mountains of Sweden, in order to observe accurately the motions of the atmosphere.

These mountains are well adapted to such a study. To the west of them lies the warm Gulf Stream; to the east is the continent of northern Europe. Consequently there the temperature contrasts are very great in winter. The temperature change along an east-west line is about 1° for each 10 kilometers in January. Here is accord-

[1] Dated July 24, 1911.

ingly a great atmospheric heat engine with its boiler over the Gulf Stream, its condenser over Russia, and the engine proper over the Scandinavian mountains.

Thus the phenomena of motion occur in very characteristic and concentrated form in these mountains. From their summits one can often follow the whole course of the cycle; the inception of the motion, the storm itself, and its final dissipation.

§ (6).

The pressure and the density of the air play the decisive rôle in the processes of atmospheric movements. One may with advantage substitute for density the specific volume of the air (i. e., the volume of a gram of air expressed in cubic centimeters). One may then very appropriately express graphically the condition of a particle or a mass of air by adopting pressure and specific volume as coordinates in a plane where the specific volume is the abcissa, positive to the right, and the pressure is the ordinate, positive downward, because in the atmosphere the pressure increases downward. If the condition of the particle or mass of air under consideration remains unchanged [during its movements], then this fact will be indicated in the adopted plane of coordinates by a point. On the other hand, if the condition changes [either as to pressure or temperature or mass, or both], then there results a line. This line we shall call the "Curve of change of condition."

Evidently the solutions of the general hydrodynamic equations of motion and of condition represent all the atmospheric movements corresponding to the most general and most complex curves of change of condition. If then we can find even one single law in these curves, we shall perceive the possibility of simplifying the hydrodynamic equation curves for meteorological purposes. The simpler the curves appear so much the greater will be the simplifications that the equations are capable of.

Among the forms which these curves of change in condition may show, the loops would be the most significant, because they represent transformations in atmospheric energy, i. e., the loops represent cyclic atmospheric processes. It is therefore advantageous to first investigate some simple combinations of loops. I selected Figure 5 for this purpose before I left for my sojourn in the mountains. The loops marked + represent cyclic processes whereby heat is converted into energy of motion. The loops marked − represent cyclic processes whereby energy of motion is converted into heat. It was of course clear to me from the start that I could not follow the very same air particle, or even the same air mass, for a sufficient length of time to enable me to draw a curve of change of condition as long as that in this diagram, but I hoped to have opportunity to sometimes plot

a portion of a curve of change in condition as actually experienced. I intended to then combine these portions into a large diagram whose accuracy was to be tested by actual observations. This diagram would then appear either more complicated, or perhaps even simpler, than that presented in figure 5. In this latter case a considerable simplification could be made, while in the former case it would still be worth while to attempt simplification.

§ (7).

My very earliest observations yielded the following facts:

(*A.*) *Every atmospheric movement involving great acceleration is either an ascending or a descending one.*

I sought to explain this fact by means of the laws of energy and of the theory of heat. The amount of energy, E, which is transformed from heat to energy of motion in an atmospheric cyclic process is known to be

$$E = m\int pdv, \qquad (1)$$

where the integration must be carried throughout the whole cycle, so that the final condition becomes identic with the initial condition. Of course this can be true for only the loops of figure 5. According to the theory of integration the amount of the integral is equal to the areal content of the appropriate loop. If we make $p =$ constant in equation (1) then the curve of figure 5 becomes simply a horizontal line and this can not inclose an area. It follows that if $p =$ a constant, then $E =$ zero, hence

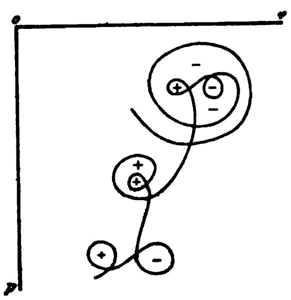

FIG. 5.—Hypothetical curve of changes of condition.

(*B.*) *In horizontal movements of the atmosphere no energy of motion is produced.*
whence follows immediately:

(*C.*) *Every movement in the atmosphere which converts heat into mechanical energy must be either an ascent or a descent.*

These laws deduced from the theory of heat explain the results of my observations as referred to above.

§ (8).

My observations have further shown that:

(*D.*) *Closed cycles are avoided in the atmosphere.*

Among all the air currents that I have observed, I have never identified a completed cycle, they have all been open.

These observations have more and more convinced me that this must necessarily be so. I soon recognized a certain object in these

processes, viz, that the object of each atmospheric current, whether ascending or descending, was always the transfer of an air mass from one level to another. But this is not attained by a closed cycle, for in that case the air mass must return to its initial level.

Often I could distinguish between the following phases of the air current: (1) A contraction of the air; (2) an irruption through the surrounding air; (3) the current of air; (4) the spreading out of the air when it had attained the appropriate level.

These four phases are found, e. g., in that atmospheric movement that produces cumulus clouds. This movement is pictured in figure 6. The surface of the earth is warmed by the sun's rays, and in turn warms the air lying next above it. This heated air collects over the higher points, and when a sufficient amount is amassed there occurs an irruption through the overlying air, whereby an ascending current of heated air originates. Evidently the air gathers into these currents, and the ascending movement sets up, because the heated air is specifically lighter than the surrounding atmosphere. During the ascent the air changes adiabatically, consequently it soon reaches that level at which its specific gravity becomes the same as that of the surrounding air. If the air should continue to ascend it would become specifically heavier than the surrounding air, therefore it spreads out at this level.

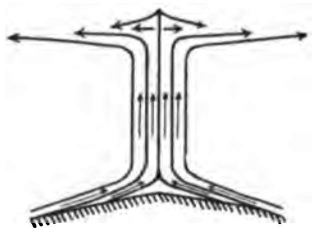

FIG. 6.—Ascending atmospheric movement.

This characteristic procedure can be observed in the mountains, both for ascending and descending air currents.

Naturally these observations and reflections have essentially modified my former views as to the processes of atmospheric movements. Thus, for example, I formerly considered the movement called forth by the sea breeze as of the nature of a completed cycle, the air over the land being warmed and consequently ascending, while the air over the water was cooled and therefore descended. These ascending and descending air currents should then set in motion compensatory horizontal movements which would combine with the vertical currents to form a closed, or cyclic, circulation as indicated in figure 7.

However, a brief reflection showed that the air movement which sets up a sea breeze can not develop in this simple way. The heated air of the upper horizontal atmospheric current must be cooled at C (see fig. 7), in order to descend; but the cooling influence of the sea does not extend upward far enough to accomplish this. The air must therefore remain above and spreads out laterally at this level so that the air movement becomes such as is depicted in figure 8.

From these considerations there directly results the following theorem:

In order that a closed cyclic circulation may be set up in the atmosphere as the result of heating and cooling of the air, it is necessary that the source of cooling be located at a higher level than the source of heating.

If then the closed cyclic circulation shown in figure 7, is to be set up, the center of heating must be located at W, and the center of cooling at C of that figure.

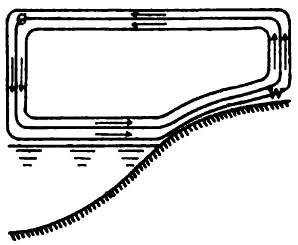

FIG. 7.—Hypothetical circulation under sea-breeze conditions.

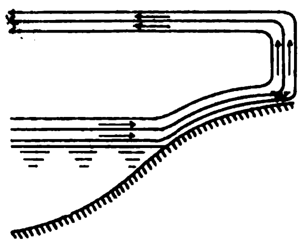

FIG. 8.—Actual circulation under sea-breeze conditions.

From the above it is sufficiently clear how seldom the conditions favoring a closed cycle of atmospheric circulation can be satisfied. However, in exceptional cases such conditions may occur, e. g., in the case of a land wind on a mountainous coast. Here the air, warmed by the sea, ascends and then spreading out laterally touches the high mountains which are very cold in consequence of radiation. By this contact the air is cooled and consequently descends again, along the mountain slopes, and flows back to the sea, as is indicated in figure 9. The condition favoring a closed cyclic circulation is here present, since the cooling source C lies higher than the heating source W.

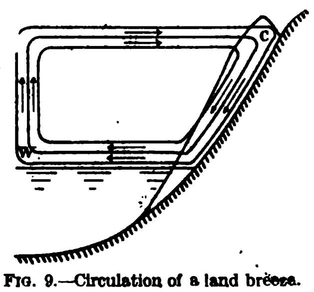

FIG. 9.—Circulation of a land breeze.

§ (9).

After these preliminary observations and considerations on the nature of the processes of atmospheric movements it will be comparatively easy to form an idea as to the changes in condition undergone by the air masses involved in such movements. We may here disregard the horizontal movements, since they do not call forth any transformation of energy and are thus of slight importance. The change in condition of the air that takes part in these latter movements is very slight, and the condition may be represented by a point, in the system of coordinates of figure 5.

An ascending air current is always initiated by an increase in the specific volume of the air, be it due to heating or to increase in mois-

ture content, or otherwise. The pressure does not change with this change of condition, and may therefore be represented by a point in the plane of coordinates, figure 5. The same system of coordinates is again presented in figure 10, where the change in condition just mentioned is represented by the line *ab*. Here the point *a* represents

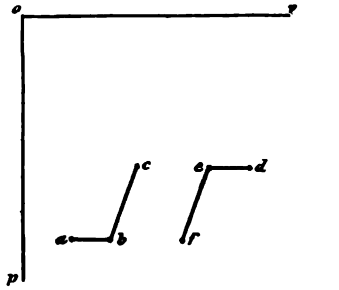

FIG. 10.—Changes of condition for ascending or descending air currents.

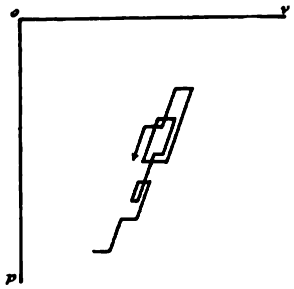

FIG. 11.—Actual curve of changes of condition.

the initial condition of the air and *b* its condition after it has expanded. In consequence of the expansion the air begins to ascend, whereby it changes adiabatically and this change in condition is represented by the line *bc* of figure 10. At *c* the ascending air mass has attained the density of the surrounding air, consequently it spreads out laterally at this level, the ascensional movement ceases and no further change in condition takes place.

FIG. 12.—Mountaineering in snow in Sweden.

A descending air current is initiated by a decrease in the specific volume; this is represented by the line *de*, figure 10. In consequence of this contraction the air begins to descend, changing adiabatically at the same time, as indicated by the line *ef* of figure 10. At *f* the descending movement ceases, the air spreads out horizontally and experiences no further change in condition.

When one follows the course of an air particle for a long time it is found to take part, from time to time, in horizontal, ascending, and descending currents. In the first case its condition does not change; in the other cases its change in condition is represented by one or the other of the curves of figure 10. The curve of condition of the particle will then be composed of these two elemental curves in

various combinations; figure 11 presents such a curve. Although the curves of change of condition of atmospheric air particles may become very complicated in the course of time, nevertheless they are merely composed of a number of isobaric and adiabatic portions. For the former or isobaric sections we may set $p = constant$ in the hydrodynamic equations of motion and condition, while for the latter or adiabatic sections the simplifying adiabatic relations may be inserted. In both cases the equations become so simple that it will be possible to base weather predictions upon them, by employing appropriate mechanical and graphic aids.

The first problem we set ourselves has then been solved at least in principle.

Chapter 3.—The Transformations of Energy Taking Place in the Atmosphere.[1]

§ (10).

All movements of the atmosphere originate from heat. In the case of the mountain storms, already described in the first paper[2] of this series, I found it easy to follow the transition from heat to kinetic energy or energy of motion.

Heat had caused the water to evaporate at the water surface. The water vapor thus formed ascended to high altitudes. There it condensed, froze, and fell upon the mountains in the form of snow. This snow remained where it fell motionless on the mountains for a longer or shorter period. In consequence of its considerable altitude above sea level, this snow upon the mountains possesses a very great potential energy, which is evidently derived from the heat that once raised the water vapor. If now this snow is whirled up into the air there originates a mountain storm whereby the potential energy of the snow is converted into kinetic energy (or the energy due to motion). In this mountain storm the snow sinks from a higher to a lower level, whereby it evidently loses a portion of its potential energy; thus the storm that originates during this change shows that the potential energy that is lost has passed into kinetic energy and been consumed as a storm.

Thus, when a storm rises, the potential energy appears as an intermediate condition between heat and kinetic energy. A little reflection leads to the conclusion that heat never directly causes a wind, but rather that the wind originates from the potential energy. The heat must first be converted into potential energy and the latter in its turn into kinetic energy of movement.

[1] Dated Stockholm, Sept. 3, 1911.
[2] Air movements in the mountains of Sweden.

We may, to a certain extent, compare this process in the atmosphere to a steam engine whereby heat is converted into mechanical work. In the engine the gaseous or fluid water is confined in metal vessels whose walls maintain it at the proper pressure. In the atmosphere there are no such rigid walls; disregarding here the earth's surface, gravity is the only force opposed to the pressure of the vapor and air. The energy that is stored up in the compressed water vapor of the steam engine appears again as potential energy in the heat engine of the atmosphere.

Except the extremely small movements due to the expansion of a warmed or the contraction of a cooled mass of air, heat alone can not call forth any motion in the atmosphere. A mass of air when heated becomes specifically lighter than the surrounding air and thus acquires the tendency to rise through the latter, just as a gas filled balloon has a tendency to ascend through the surrounding atmosphere. The balloon possesses a certain quantity of potential energy which is converted into kinetic energy during its ascent; the same is true of the heated air mass. On the other hand a mass of cooled air becomes denser than the surrounding warmer air, and thereby acquires a tendency to sink through the latter. This air mass therefore possesses a certain quantity of potential energy which is converted into kinetic energy during the descent of the air, just as a heavy body converts its potential energy into kinetic energy during its fall.

In the atmosphere, therefore, it is only the ascending or descending air currents that generate kinetic energy. An air mass that neither ascends nor descends, but remains always under the same pressure during its motions, can not generate any kinetic energy. This fact is made very clear in the well-known equation of energy of thermodynamics,

$$E = m\int p dv \quad \ldots \ldots \ldots \quad (1)$$

If we put

$$p = \text{constant} = p_0$$

we then have

$$E = mp_0 \int dv,$$

and since we assume the air to go through a closed cycle, i. e., the final value of v to be the same as its initial value v_0, hence we have

$$\int dv = v_0 - v_0 = 0,$$

whence also

$$E = 0.$$

Hence, in the atmosphere, the heat is first transformed into potential energy. Obviously this potential energy can not be reconverted into heat; it can only pass over into kinetic energy. The kinetic energy of motion can pass back into potential energy, as it

does do, for example, in the wave motions of the atmosphere. The kinetic energy may also pass directly into heat by friction. Summarizing all this, we may represent the energy transformations taking place in the atmosphere by the following scheme:

$$\text{Heat} \rightarrow \begin{Bmatrix} \text{Potential energy} \rightarrow \text{Kinetic energy} \\ \text{Potential energy} \leftarrow \text{Kinetic energy} \end{Bmatrix} \rightarrow \text{Heat.}$$

§ (11).

We have just seen that any movement of the air by which kinetic energy is developed must be either ascending or descending. In either case the conditions may be properly compared to those obtaining in a waterfall, and the kinetic energy generated by the air current may be estimated in the same way that one obtains the energy developed by a waterfall.

In order to determine the energy developed by a waterfall, it is to be remembered that 1 horsepower = 75kg-m-sec, and that 1 cubic meter of water weighs 1,000 kilograms. If now a waterfall delivers N cubic meters per second and the fall has a drop of H meters, then the power P developed by it expressed in horsepower is

$$P = 13.33\ N.\ H \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

But a waterfall is nothing more than a heat engine, and the energy developed by such an engine is given by formula (1). It must then be possible to derive (2) from (1). This we shall now proceed to do and at the same time bring the energy formula into such a form that the work done by the air current, or its total energy, is expressed in horsepower.

In formula (1) p = pressure, v = specific volume, m = mass of the fluid or gas taking part in the motion, and E = kinetic energy developed. In its derivation it is assumed that the final and initial conditions of the fluid or gas are identical. If we employ rectangular coordinates where v is the abscissa and p the ordinate (the latter taken negatively, so that the pressure may increase downward, as in nature), and plot on this all the conditions passed through by the air in the course of its movements, there results a closed curve. This system of coordinates and the closed curves are shown in figure 13.

The ordinates are positive downward as the atmospheric pressure increases downward. According to the theory of integrals the total integral equals the area bounded by the curve in figure 13. But the value of the integral can not be ascertained in this direct manner because in cases of atmospheric processes it is very seldom that the curve of condition for a particle of air is a closed curve. For instance let us consider the case of an ascending air movement. The point a in figure 14 may be taken to represent the initial condition of the air

taking part in the air movement. This air is now warmed. Its specific volume thereby increases from *a* to *b*. The mass begins to rise, thereby expanding adiabatically because it has grown lighter than the surrounding air. The accompanying change in condition which this air experiences is represented by the line *bc*. At *c* the air

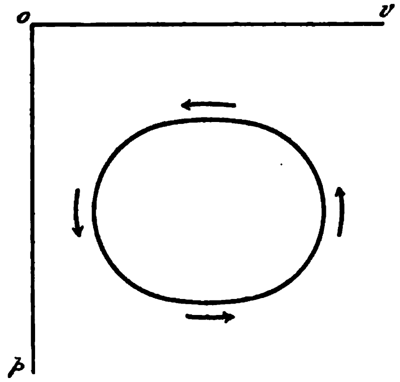

FIG. 13.—Changes of condition during a cyclic process.

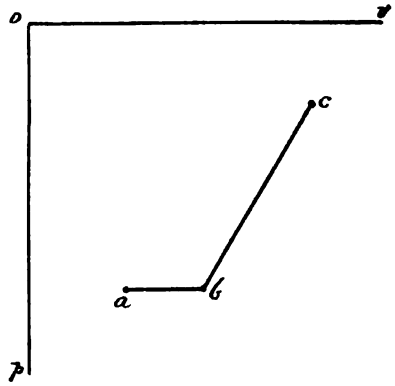

FIG. 14.—Change of condition of an ascending atmospheric current.

mass attains its final condition; its ascent ceases and no further kinetic energy is produced.

Since the curve of changes of condition, *abc* of figure 14 does not inclose a surface, the appropriate integral from formula (1) can not have a definite value. In order to make that formula applicable to this case also, we must recall that the air which rose from high pressure at *a* to low pressure at *c* descends again from *c* to *a*, and in such a way that no energy is thereby lost or gained. This is the case only when the descending air always has the same specific volume as that of the surrounding air. On plotting, in figure 14, the conditions passed through by the air during such a descent we obtain the curve *ca*, as shown in figure 15, which converts the complete curve of changes of condition into a closed curve *abca*.

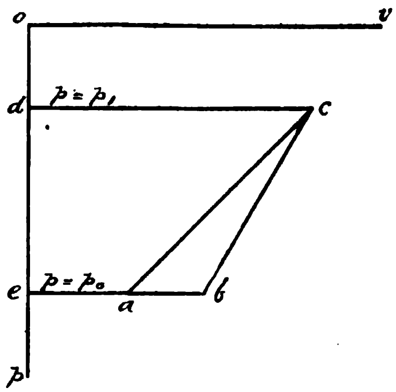

FIG. 15.—Energy developed by an ascending air current.

If the integral of formula (1) is put equal to the area bounded by the curve *abca* of figure 15 then the formula gives the energy developed by the total air movement. But this is nothing else than the energy

developed during the ascent, for no energy has been consumed or developed during the descent of the air mass.

But the area *abca* of figure 15 is equal to the difference between the two areas $b\ c\ d\ e\ b$ and $a\ c\ d\ e\ a$. Now the surface $b\ c\ d\ e\ b$ is equal to $\int_c^b v.dp$, or if we integrate upward (i. e., in the direction of decreasing pressure) the surface $b\ c\ d\ e\ b$ equals $-\int_b^c v.dp$. In the same way the surface $a\ c\ d\ e\ a$ equals $-\int_a^c .dp$, and accordingly the surface

$$abca=\int p.dv=-\int_b^c v.dp+\int_a^c v.dp. \quad . \quad . \quad . \quad . \quad . \quad (3)$$

The barometric formula reads $dp=-g\rho dz$ where $\rho=1/v$, whence $-v.dp=g.dz$, and this value substituted in 3, gives

$$\int p.dv=\int_b^c g.dz-\int_a^c g.dz.$$

If we substitute herein mean values for the acceleration of gravity we have

$$\int p.dv=g_1\int_b^c dz-g_2\int_a^c dz.$$

The integrals $\int_b^c dz$ and $\int_a^c dz$ here represent the vertical distances between the two atmospheric levels corresponding to the points b and c or a and c, respectively in figure 15. In other words $\int_b^c dz$ equals the vertical interval h_1 between the two isobaric surfaces p_2 and p_1 within the air current and $\int_a^c dz$ equals the vertical interval h_2 between the same isobaric surfaces without the air current.

Accordingly equation (3) becomes

$$\int p.dv=g_1h_1-g_2h_2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Here g_1 and g_2 may be put equal to each other, therefore

$$\int p.dv=g(h_1-h_2) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Substituting from (5) into 1, we have

$$E=m.g\ (h_1-h_2) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

Here E represents the total energy developed by the air current and m the total mass of air taking part in the current. If it is desired to derive e, the energy developed during a unit of time, then m

must be replaced by the mass of air n passing through any given cross-section of the current in a unit of time.
Whence

$$e = n.g\,(h_1 - h_2) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

The energy e will be expressed in *C.G.S.*-units if the quantities in the right-hand member of equation (7) are expressed in that system. Since one horsepower is 736×10^7 *C.G.S.*-units, hence (7) may be written

$$P = n.g.(h_1 - h_2)/736 \times 10^7 \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

If, now, we express the flow of air in tons-per-second rather than in grams-per-second, and the difference in altitude $h_1 - h_2$ in meters instead of centimeters, and put

$$N = n/10^6,$$
$$H = (h_1 - h_2)/100,$$
$$g = 981,$$

then equation (8) becomes

$$P = 13.33\ NH \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

which expresses in *C.G.S.*-units the energy developed by a waterfall. We may then formulate the following theorem: *Every air current may be compared to a waterfall discharging a mass of water equal to the mass of air discharged by the air current, and having a fall equal in height to the difference in altitude between the isobaric surfaces within and without the air current. The energy expended by the air current equals that developed by such a waterfall.*

§ (12).

Two examples may serve to show the applicability of this law of energy.

(*A*.) Figure 16 presents the atmospheric circulation characteristic of the formation of cumuli. The ground is heated by the insolation and the adjacent air is warmed. This warmed air collects at higher points and there breaks through the superjacent cooler air. The hot air rises until it attains that level where its own specific gravity is the same as that of the surrounding air; there it spreads laterally.

Assume that the temperature of the ascending air is higher than that of the surrounding air, by 3°; that the ascensional velocity is 1 decimeter per second; that the total thickness of the current is 1 kilometer and that the area of its cross section is 1 kilometer². We will calculate the energy expended by this air current.

In this case the air current discharges about 100 tons of air per second, so that the corresponding waterfall to be compared with it delivers about 100 cubic meters of water per second. Since the air is

warmer within the ascending current than it is without, the vertical distance between the isobaric surfaces is greater within than it is without the current, and in this present case the difference amounts to about 1 per cent. As the current is 1 kilometer deep, therefore the vertical distance between two isobaric surfaces within and without the current (one at the bottom where $p=p_0$ and the other at the top of the current where $p=p_1$) will amount to about 10 meters, being greater inside than outside the ascending current of air. Accordingly the corresponding waterfall with which the air current is to be compared will be about 10 meters high. On placing $N=100$ and $H=10$, in equation (2) we find that the energy developed by this air current is $P=13{,}330$ horsepower.

(*B*) For a second example we may calculate the energy expended by the Gulf Stream. The discharge of this current is estimated as being 25,000,000 tons per second. The vertical interval between two isobaric surfaces, the one $p=p_0$ in the oceanic depths beneath the Gulf Stream and the other $p=p_1$ near the ocean surface, is 1.5 meters greater under the Tropics than it is in the polar regions. Accordingly our corresponding waterfall with which to compare the Gulf Stream has a height of 1.5 meters and a discharge of 25,000,000 cubic meters per second. Substituting these values of H and N in (2) it appears that the energy expended by the Gulf Stream amounts to $P=$ 500,000,000 horsepower.

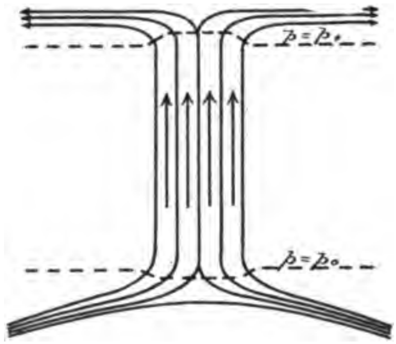

FIG. 16.—Atmospheric circulation during the formation of cumuli.

These two examples show that by this method it is extremely simple and easy to solve atmospheric and hydrographic problems in energetics. Of course more complicated considerations may be combined with these simple computations.

For example, it has long been a question of discussion whether the Gulf Stream is driven by the melting of the edge of the polar ice or by the low temperature of the air over the arctic basin. This question may be decided if we plot the vertical distances of the isobaric surfaces $p=p_0$ and $p=p_1$, as given by hydrographic observations, all along the Gulf Stream; see figure 17.

This interval or vertical distance decreases steadily from the Tropics toward the arctic region and, as mentioned above, the total decrease amounts to 1.5 meters. If this decrease is a uniform one, as represented by the dotted line in figure 17, then the melting ice has

no particular effect in driving the Gulf Stream; but if the decrease in the interval is most rapid in the region of the melting ice, as indicated by the full line of figure 17, then the melting must exert a decided influence upon the movement of the water of the Gulf Stream.

Naturally there are many oceanic phenomena that may be elucidated by such investigations; there are also a number of atmospheric phenomena for which this will hold true. This is probably the case, e. g., with regard to the rôle played, by the water contained by the atmosphere. Enormous masses of water ascend in the atmosphere, representing all that water which later descends again as rainfall or precipitation in general. From our point of view the ascent of all this water may be considered as a waterfall which must possess a very great energy. During the ascent of the water vapor in the atmosphere a large quantity of kinetic energy is generated and this appears in the form of violent winds, as indeed is clearly seen in the case of the cyclones that form over the Gulf Stream. On the other hand the heat liberated by the condensation of the water vapor calls forth far-reaching transformations of energy, for this heat is transformed into potential energy in the manner already outlined, and this in turn becomes kinetic energy. Finally, the descending rain is to be compared with a waterfall of large volume but of slight height, producing a considerable quantity of kinetic energy in the same way as does the mountain storm called forth by the admixed snow in the air. The above laws of energy enable us to calculate the parts played by all these processes in producing the winds.

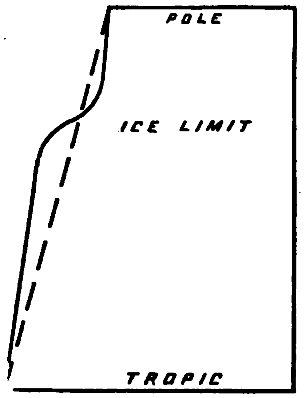

FIG. 17.—Diagrammatic presentation of the distribution of pressure in the Gulf Stream.

Numberless problems of this kind are to be found in the atmosphere as well as in the ocean. There can be no doubt that it would shed much light on meteorological and oceanographical processes, and on their relations to the phenomena of the weather, were all the great mass of observational material now available in oceanography and meteorology to be worked over in accordance with the principles here set forth.

§ (13).

It remains to be shown that the quantity of kinetic energy developed by a given quantity of heat is largely dependent upon the degree of stability of the atmosphere. Suppose that in figure 18a, the three curves AB, AC, and AD represent different atmospheric conditions,

viz, the curve AB represents adiabatic conditions, the curve AC stable, and the curve AD unstable conditions. Now, let the quantity of heat Q be added at some point where the pressure p becomes p_1 so that the specific volume of that air is increased by the amount $\triangle v$. The air begins to rise, thereby transforming heat into kinetic energy, and, since the air at the same time also changes adiabatically, its curve of condition runs parallel with the "adiabatic curve of condition," *AB*. The kinetic energy generated is proportional to the shaded areas in figure 18a [stable conditions on the right and unstable on the left. On the other hand, if the quantity $\triangle v$ of heat

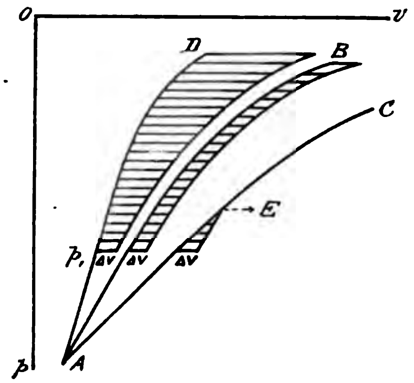

FIG. 18a.—Energy corresponding to ascending currents of air.

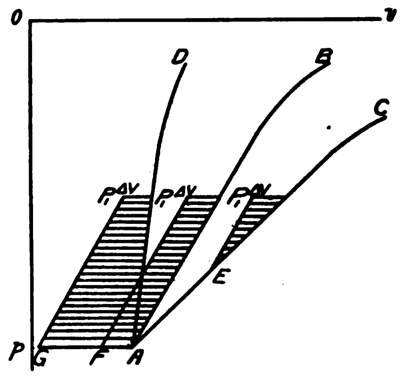

FIG. 18b.—Energy corresponding to descending currents of air.

is abstracted from this mass of air under pressure p_1 and the cooled air descends to the pressure p and warms adiabatically as in figure 18b then the amount of kinetic energy utilized in falling is as shown by the corresponding shaded areas.] Thus, both the addition and the abstraction of heat are covered by the following theorem relative to kinetic energy in our atmosphere:

The more stable is the condition of the atmosphere, the smaller is the quantity of kinetic energy generated by a given quantity of heat Q, and the more unstable the atmosphere so much greater is the quantity of kinetic energy developed by the same quantity of heat Q.

When the atmospheric conditions are very stable a very considerable quantity of heat may be added to or withdrawn from the air without producing any noteworthy disturbance of the balance; on the other hand, under unstable conditions, it requires but a slight gain or loss of heat to call forth such catastrophic phenomena as give rise to thunderstorms and hail squalls, etc.

Chapter 4.—On the Utilization of Balloon and Kite Observations in the Study of the Dynamic Phenomena of the Atmosphere.[1]

§ (14).

While studying the dynamic conditions of the atmosphere in the mountain regions of Sweden I could several times have made great use of observations by balloons and kites, had such been available. I have studied out the methods that should be employed in utilizing these, and my conclusions are given below.

The observations should be worked out as follows: First, the specific volume of the air should be calculated from the collective values of temperature, pressure, and moisture; then the corresponding values of pressure and specific volume should be entered in a coordinate system having the specific volume as abscissa, positive to the right, and the pressure as ordinate, positive downward. The curve thus obtained in this system of coordinates we may call the curve of atmospheric condition for the place and time when the kite or balloon ascension was made.

The above coordinates should be printed prominently in a decidedly darker color, but the adiabats [for both saturated and for dry air] in a lighter color and less prominently. We should then be able to separate readily those parts of the curve of condition where the atmospheric conditions at the time of the ascension were, respectively, stable, adiabatic, and unstable.

We shall thus find, in general, that the greater part of the atmospheric curve of condition is stable and only small parts thereof can be either adiabatic or unstable. Besides this the curve of condition will show a number of bends and angles, whose meaning we shall attempt to interpret.

Assume that an atmospheric stratum becomes heated because the clouds absorb the rays of the sun. If from the observations obtained in this stratum by means of a kite or balloon passing through it, we construct the atmospheric curve of condition and it shows a deflection to the right, as in figure 19, then the curve of condition indicates stable condition throughout, except along the thin stratum *ba* which corresponds to the upper part of the warmed stratum where the condition is unstable.

On the other hand, if an atmospheric stratum becomes cooled, e. g., because the clouds radiate heat toward the sky during the night and the kite or balloon passes through the cold layer, then the curve of condition throughout this stratum will show a deflection to the left as in figure 20.

[1] Dated Oct. 16, 1911.

This curve will thus indicate stability throughout, except at the level *ba* which corresponds to the lower part of the cooled stratum in the atmosphere where the condition is unstable.

But the heating is accompanied by a rising of the heated air, and the cooling by a sinking of the cooled air. In both instances the heat

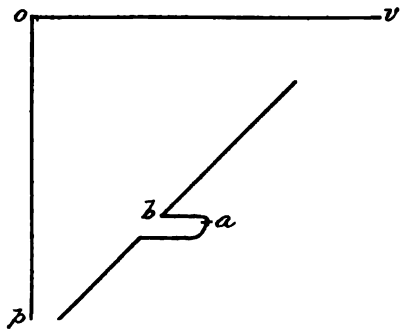

FIG. 19.—Curve of condition, instability due to heating at the level *ba*.

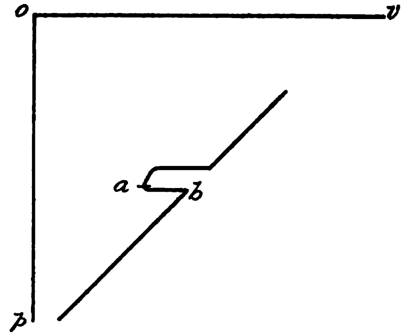

FIG. 20.—Curve of condition, instability due to cooling at the level *ba*.

is converted into energy. We may therefore draw the following conclusion:

Every movement of the air by which heat is converted into energy is preceded by instability in the atmospheric condition.

The movement itself may be either intermittent or continuous. Figure 21 shows three stages of an intermittent ascending movement. At (1) the heated air collects until it has gathered sufficient force to break through the air lying above it; at (2) the heated air is in the act of rising; and at (3) it has reached the altitude where it has the

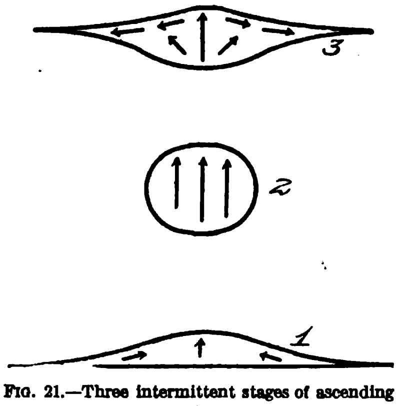

FIG. 21.—Three intermittent stages of ascending air.

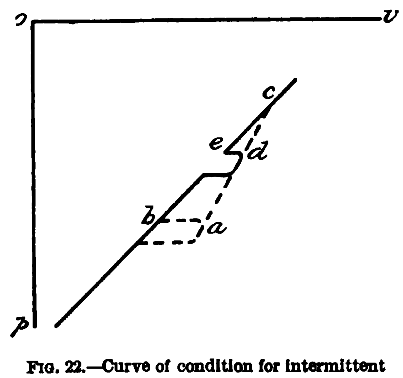

FIG. 22.—Curve of condition for intermittent ascent of air.

same specific gravity as the surrounding air and is expanding on all sides.

The condition of this disturbed air will change adiabatically while rising. This adiabatic change may be illustrated by drawing an adiabat upward from the point *a* in figure 22.

The solid line in figure 22 shows the atmospheric curve of condition one would experience while traveling by balloon or kite through a heated air stratum that is in the second condition shown in figure 21. In figure 22 I have shown not only the original curve of condition as in figure 19, but also by dotted lines the adiabatic line *adc* through the point *a*. While the air rises from 1 to 3 in figure 21, the deflection *a* in figure 19 moves like a wave upward along the curve of condition, and its amplitude grows gradually smaller by reason of continuous contact with the adiabatic line *adc* of figure 22. At the point *c* where this adiabat cuts the curve of condition the deflection disappears entirely. In a similar way the curve of condition, figure 20, changes for a deflection due to cooling. In that figure the deflection *ba* gradually becomes smaller as the disturbed layer sinks and the condition curve follows along an adiabat through *a*, figure 20, until it disappears. During this entire descending movement of a cooled mass the deflection touches the adiabat drawn through the point *a* (just as in the case of the ascending movement of a warmed mass).

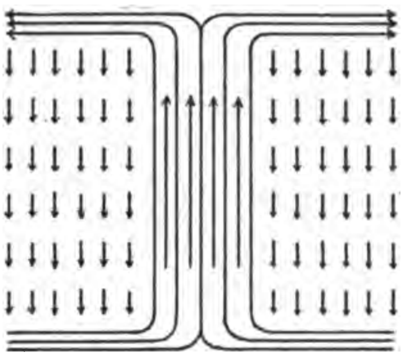

FIG. 23.—Continuous compensatory interchange of atmosphere.

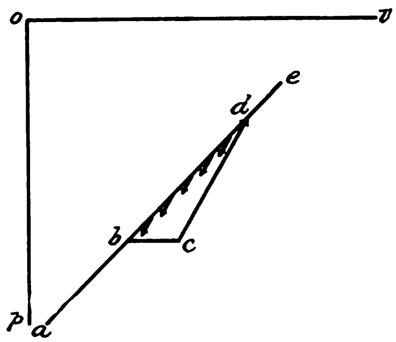

FIG. 24.—Curve of condition for rising air and descending compensation.

During the continuance of this wavelike modification of the curve of condition there is always left an unstable remnant of the curve of condition shown by the lines *ab* in figures 19 and 20, and *de* in figure 22. Thus such a modification is a sign of a rising (or falling) intermittent air current.

If, on the other hand, the air movement is not intermittent but steady and continuous then the movement will take place not as in figure 21, but as shown in figure 23.

The heated air breaks through the air above it and then through this channel new masses of air will flow continuously; thus great masses of air are moved upward. The air surrounding the ascending current necessarily sinks somewhat in order to replace the air which has been removed from below, and to make room for the air that is

added above. The small arrows directed downward in figure 23 indicate this compensatory interchange of air.

The curve of condition of the atmosphere that would be given by observations made during a balloon or kite ascension in the sinking air, outside the ascending air current of figure 23, is shown by the straight line *abde* of figure 24, whereas the broken line *abcde* represents the curve of condition given by an ascension within this ascending current.

This second curve of condition contains no unstable portion; on the contrary, the deflection *bcd* for the region of the rising air current consists of a horizontally stable part *bc* and an adiabatic part *cd*. Such a modification of the curve of condition thus indicates a continuous rising air current.

Figure 25 shows a corresponding curve of condition for heavy masses of air sinking within a continuous descending air current.

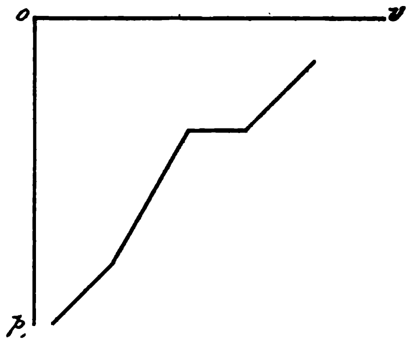

FIG. 25.—Deflection of curve of condition for continuous descending air.

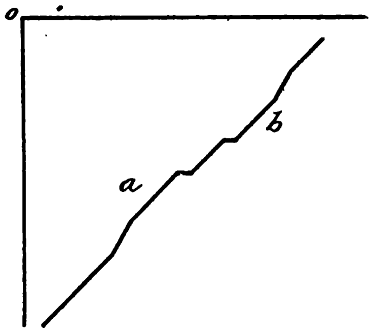

FIG. 26.—Remnants of curve of condition; *a*, for sinking air; *b*, for rising air.

The small arrows pointing downward in figure 24 indicate the changes of condition occasioned by the compensatory sinking of the air. (See the small arrows pointing downward in figure 23.) Thus, on account of the descending compensatory movement of the air, the curve of condition of the surrounding air is shifted somewhat to the right so that it passes through the tips of these small arrows. (See fig. 24). When the ascending movement ceases the new curve of condition, thus shifted, is the only remaining trace of what has taken place. Even the intermittent movement of rising air in figure 21 causes such a permanent trace in the curve of atmospheric condition; for even in this case there must occur a compensatory downward sinking of the surrounding air. On the contrary when air is sinking the curve of condition becomes shifted to the left, corresponding to the compensatory upward movement of adjacent air. (See fig. 25.)

Figure 26 shows the traces in the atmospheric curve of conditions remaining (*a*) after a sinking movement, and (*b*) after a rising move-

ment. These deformations of the curve of condition are a combination of one horizontal stable part and one part due to the parallel shift of the curve of condition and, finally, one adiabatic part. When such deformations occur in the atmospheric curve of condition it is plain that these are traces of recent rising or sinking movements of the air.

If light air rests on heavier air, then wave motions are likely to occur in the stratum between the two masses of air. By studying figure 27 more closely it will be seen what influence these wave motions have on the curve of condition of the atmosphere. The horizontal line in this figure represents the boundary between two air strata, and the dots represent the positions of some suspended air particles all at rest. If, now, a wave motion occurs at the interface, this in turn will set in motion not only the air at the interface but also the surrounding air. The arrows in figure 27 represent the vertical components of this oscillatory motion of the air. Figure 28 represents the corresponding curve of condition of the atmosphere when in

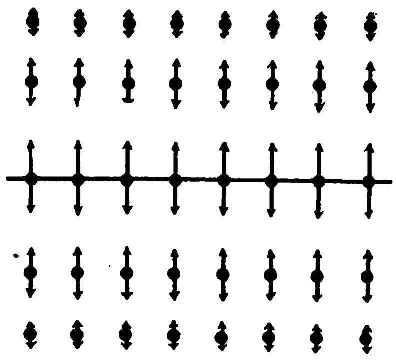

FIG. 27.—Vertical oscillations of two superposed adjacent layers of air.

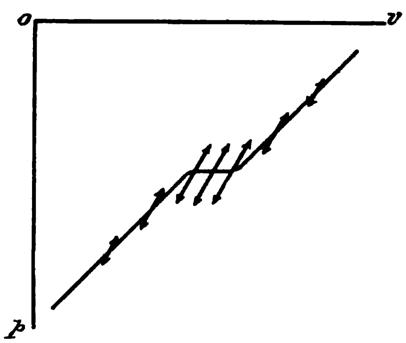

FIG. 28.—Curve of condition of atmosphere in equilibrium and its changes due to oscillations.

equilibrium, the arrows crossing slantingly in this figure indicate the changes of condition that have been caused by the vertical motions indicated in figure 27. The changes in the atmospheric curve of condition indicated by the arrows in figure 27 occur, of course, in rather swift sequence. If, therefore, a kite or balloon is sent up through such an oscillatory motion the curve of condition of the air will have a very complicated appearance; and this will be more marked in proportion as the ascension is slower. If the ascension is made with a uniform speed, the curve of condition will have the simplest appearance. It will then resemble a sine curve connecting geometric points corresponding to the arrows in figure 28. When interpreting such curves of condition, great care must be exercised on account of the great part played by the duration or rate of the ascension. For instance, the curve of condition might indicate instabilities that do not exist in the atmosphere.

In conclusion I can not omit to point out of what great value, from a dynamic point of view, it would be if the vertical velocity of the air could be measured during kite and balloon ascensions. If a statement of the vertical speed of the air could be placed alongside the curve of atmospheric condition, it would decidedly simplify the interpretation thereof. In many instances where the form of the curve of condition may now be interpreted in various ways, it would then admit of but one interpretation. For instance, with the aid of observations of the vertical velocity one could in every case decide what changes in energy took place and to what extent they occurred in the atmosphere at the time of the ascension. Generally speaking, one may say that such vertical speed data would render kite and balloon observations far more valuable than they now are for the interpretation of dynamic phenomena in the atmosphere.[1]

CHAPTER 5.—ON THE VORTEX MOVEMENTS OF THE ATMOSPHERE.[2]

§ (15).

During my meteorological observations among the mountains of Sweden I found the hydrodynamic vortex theory very useful. In particular I applied that property of vortex lines whereby they can not terminate freely in a fluid. Atmospheric movements which at first glance seem to be wholly distinct from each other and quite different in their natures were found to be so closely bound together that by the course of these vortex lines the whole phenomena of motion seemed to become very clear and simple. In this way I gained a good comprehension of the very complicated movements of the air.

There have been previous attempts to employ the hydrodynamic vortex theory in such studies. Thus Wegener[3] sought to explain the development of tornadoes (or trombes), but his attempt only serves to show that many are insufficiently acquainted with the hydrodynamic vortex theory. This latter vortex theory regards a vortex filament as an infinitely thin bundle of vortex lines which are constantly in mutual contact. Wegener defines a vortex filament quite differently, viz, as a fluid rotating about an axis. He then transfers to these filaments directly the properties of the like-named hydrodynamic concept, and thus comes to the conclusion that the vortex axes can not end freely in a fluid, a conclusion which is in striking contradiction to theoretical hydrodynamics and to practical experience.

[1] A special effort to obtain such data was made by Prof. Abbe in his instructions for, and by Prof. Upton in his observations during, the balloon voyage from Minneapolis of S. A. King on Apr. 22, 1881 (see Ann. Rep. C. S. O. 1882, p. 76 and pp. 863–8).—C. A.

[2] Dated Stockholm, Nov. 5, 1911.

[3] Wegener, Alfred. Ueber den Ursprung der Tromben. Met. Zeit. Mai, 1911.

It appears that the elegant and important researches on vortices and atmospheric circulation by von Helmholtz [1] and Lord Kelvin [2] have not received the attention they deserve from meteorologists. I shall therefore insert here a brief introductory statement of those definitions and laws of the hydrodynamic vortex theory which are most important for the meteorologist, basing my presentation chiefly upon that of F. Auerbach as found in A. Winkelmann's Handbuch der Physik.[3] I shall also give numerous simple examples illustrating and explaining my theorems.

§ (16).

The *vortex line* is the fundamental element of ideal whirling fluids. It is constructed by associating with any rotating particle of a fluid the neighboring particle lying in the direction of the axis of rotation of this initial particle; to this second particle is added the adjacent third particle lying in the direction of the axis of rotation of the second. By continuing this process and following this arrangement there results a line; this line is a vortex line.

The *vortex filament* is an infinitely thin bundle of vortex lines always in continuous mutual contact.

A vortex filament can neither begin nor end within the fluid; it must therefore cease at the boundary of the fluid, or turn back upon itself. No vortex filament can penetrate another vortex filament, nor can it penetrate any portion of itself.

The *intensity of a vortex filament* is the product of its speed of rotation by the area of its cross section. The intensity of a vortex filament remains the same for every point of that filament.

The *circulation of a closed curve* consisting of fluid particles arranged side by side, is the integral of the tangential component (the line integral) of the velocity along the whole closed curve. The circulation of a closed curve is equal to twice the sum of the intensities of all the vortex filaments embraced within the curve. All closed curves embracing the same vortex filaments within themselves have the same circulation.

§ (17).

In my investigations it was necessary to select a unit for the vortex, and I have called this the *unit vortex*. The value of this unit vortex is such that to every closed curve which it embraces it communicates a circulation of 1 $cm.^2/sec.$

[1] Helmholtz, H. von. Crelles Journal, 1858, vol. 55, p. 25, or English translation in Abbe "Mechanics of the Earth's Atmosphere," Washington, 1891, 1893, and 1910. Smithsonian Misc. Col., No. 843.

[2] Thomson, William. Trans. Roy. Soc. Edinburgh, 1867, vol. 25, p. 217, or Larmor's Reprint of Thomson's Mathematical and Physical Papers, Vol. IV, Cambridge, 1910.

[3] Winkelmann, H. Handbuch der Physik. 2te Auflage, Leipzig, 1908. Bd. 1, p. 1049.

Accordingly the number of unit vortices within any given closed curve equals the circulation of this curve, provided that the unit vortices all have the same direction of rotation. If the unit vortices have opposite directions then the circulation of the curve equals the algebraic sum of the unit vortices, denominating those of one direction positive and those of the opposite direction negative. The following special case of this theorem has proved particularly important in my studies: *When the circulation of a closed curve is zero, then this curve embraces two systems of unit vortices of equal magnitude but opposite in sign.*

Figure 29 illustrates the analysis of a vortex into its component unit vortices. Two systems of lines are drawn through the vortex in such a way that they intersect each other; each mesh formed by the intersecting systems has a circulation of 1 cm.²/sec. Vortex lines are drawn through every point of this net; these divide the vortex into a system of tubes, each of which contains one unit vortex. In figure 29 the solid arrows indicate the direction of rotation of the vortex and thus also the direction of the circulation. To this direction of rotation there may also be added a movement lengthwise of the vortex; the direction of this lengthwise motion is indicated by the dotted arrows, pointing downward in figure 29. This is the same direction as the forward motion of an ordinary right-handed screw held parallel with the direction of the vortex lines and rotated in the direction of the vortices; the (right-handed) screw then advances in the direction of the vortex.

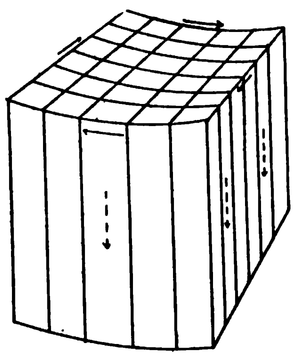

FIG. 29.—The analysis of a vortex into "unit vortices."

§ (18).

The significance of these concepts and laws may best be emphasized by employing them in the solution of several numerical examples, such as may be found everywhere in nature. In the following are given several such examples:

(A) Let us determine the number and course of the unit vortices within and surrounding a metallic axle 30 cm. in circumference, making 1 complete revolution per second, and supported by 2 metal bearings, journals or boxes, as in figure 30.

According to the statement above given the number of unit vortices within this axle equals the circulation of the periphery of the axle. The circumference of this axle is 30 cm. and its rotational speed 30 cm./sec. Hence its circulation is 900 cm.²/sec., and therefore

the axle includes 900 unit vortices. Evidently these vortices lie in the direction of the longitudinal axis of the axle.

The cross section of the axle has the area 71.66 cm.^{2}. Thus each square centimeter of the cross section includes $900/71.66 = 12.56$ unit vortices, whence each unit vortex has the cross section 71.66/900 cm.^{2} = 7.96 mm.^{2}.

At either end of the rotating axle the air is dragged with it, so tha it also acquires a rotary movement. Hence it follows that at the ends of the axle the unit vortices emerge into the air.

At some distance from the end of the axle the air does not rotate as rapidly as does the axle itself. Accordingly a closed curve at the end of the axle has a smaller circulation, and therefore embraces a smaller number of unit vortices than does a closed curve of the same size within the axle. Thus it appears that the cross sectional areas of unit vortices expand after they emerge from the axle.

The air near the surface of the rotating axle is also dragged around by it and set into rotation about it. But this rotation decreases very rapidly with increasing distance from the axle, and ceases within a short distance. At this limiting distance a closed curve around the axle has a circulation of zero, and the closed curve therefore embraces an equal number of unit vortices having two opposite directions. Now, there are 900 unit vortices within the axle and along it, rotating in one direction; therefore there must be 900 unit vortices rotating in the opposite direction, outside the axle, but within the limits of the closed curve of zero circulation. Evidently these are identical with the unit vortices that are within the axle; they have recurved at the ends of the axle and have returned back through the air.

If a closed curve be drawn around the axle and within the metal masses of the bearings that carry the axle, the circulation of that closed curve is also zero, because the bearings are at rest. This remains true no matter how closely this closed curve may approach the rotating axle. Consequently these 900 recurving unit vortices lie in the sliding surface between the axle and the bearings. Vortices which are thus localized in one surface will hereafter be called *glide vortices*.

The axle and the trends of two vortex filaments, and the supports or bearings, are shown in figure 30.

(B) As a second example, let us consider the rotation of the earth. Within the earth the vortex filaments evidently rotate parallel with the earth's axis and in agreement with the rule given in § (17) they advance positively from south to north. The equatorial circumference is equal to 40079×10^5 cm. and its linear velocity is 16514 cm./sec. (because it rotates in one sidereal day of 86,164 seconds of mean solar time). Accordingly the circulation (at the Equator) is

18642×10^{10} cm.^{2}/ sec., and this is therefore the number of unit vortices contained within the earth.

The area of the equatorial circle is 12783×10^{10} m.^{2} Consequently each square meter of this area embraces 1.4583 unit vortices, each of these having a cross-sectional area of 0.6857 m.^{2} As all vortex threads within the earth are rectilinear and parallel to the earth's axis therefore the above values hold true for all planes perpendicular to the earth's axis and within the earth.

Since the atmosphere rotates with the earth about its axis, it follows that these vortex threads emerge through the earth's surface into the atmosphere. We may calculate the number of unit vortices emerging between two given parallels of latitude by multiplying 1.4583 by the difference between the areas of the two parallels expressed in square meters. In Table 1 are given the numbers of unit vortices emerging between each 10° of latitude from the Equator to the poles.

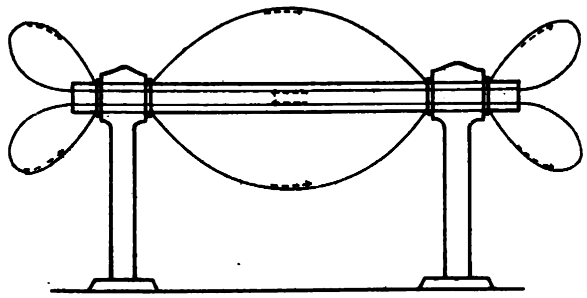

FIG. 30.—The vortex filaments of a rotating metallic axle with two bearings.

TABLE 1.—*Number of unit vortices emerging from the earth by reason of its rotation.*

Latitude.	Number of unit vortices.
0° to 10°	568×10^{10}
10° to 20°	1627×10^{10}
20° to 30°	2491×10^{10}
30° to 40°	3048×10^{10}
40° to 50°	3237×10^{10}
50° to 60°	3035×10^{10}
60° to 70°	2469×10^{10}
70° to 80°	1608×10^{10}
80° to 90°	559×10^{10}

If it be desired to determine, for example, the number (f) of unit vortices emerging through one square meter of the earth's surface it is necessary to take account of the angle ϕ which the earth's surface makes with the axis. The result is—

$$f = 1.4583 \sin \phi \quad . \quad . \quad . \qquad (1)$$

If we disregard the inequalities of the earth's surface it is sufficiently accurate to consider ϕ as equal to the geographic latitude. Table 2 gives the values of f for each degree of latitude, calculated by formula (1).

TABLE 2.—*The number of unit vortices emerging from a square meter of the earth's surface at each degree of latitude, in consequence of the earth's rotation.*

Geographic latitude.	0°.	1°.	2.°	3°.	4°.	5°.	6°.	7°.	8°.	9°.
0°	0	0.026	0.051	0.076	0.102	0.127	0.152	0.178	0.208	0.228
10°	0.253	0.278	0.303	0.328	0.353	0.377	0.402	0.426	0.451	0.475
20°	0.499	0.523	0.546	0.570	0.593	0.616	0.639	0.662	0.685	0.707
30°	0.729	0.751	0.773	0.794	0.815	0.836	0.857	0.878	0.898	0.918
40°	0.937	0.957	0.976	0.995	1.013	1.031	1.049	1.067	1.084	1.101
50°	1.117	1.133	1.149	1.165	1.180	1.195	1.209	1.223	1.237	1.250
60°	1.263	1.275	1.287	1.299	1.311	1.322	1.332	1.342	1.352	1.361
70°	1.370	1.379	1.387	1.395	1.402	1.409	1.415	1.421	1.426	1.431
80°	1.436	1.440	1.444	1.447	1.450	1.453	1.455	1.456	1.457	1.458

It is a well-known fact that in the equatorial region the upper atmospheric strata move from east to west. This air therefore has a smaller rotational velocity about the earth's axis than has the earth itself. Consequently a closed curve embracing the earth above the Equator at an altitude of 10,000 meters above sea level, has a smaller circulation than the equatorial periphery itself. Therefore the vortex filaments between sea level and an altitude of 10,000 meters run from north to south. Hence we conclude that the vortex filaments emerging from the earth over the Northern Hemisphere in the vicinity of the Equator, must at once recurve southward in order to reenter the earth on the south side of the Equator. Therefore these vortex filaments are closed.

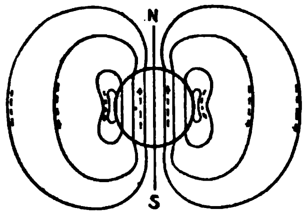

FIG. 31.—The vortex filaments of the rotating earth.

On the other hand in higher latitudes the upper strata generally move from west to east and therefore have a greater rotational velocity about the axis than does the surface of the earth. Accordingly the circulation of a closed curve which at 10,000 meters altitude in these latitudes surround the globe is greater (and embraces a greater number of unit vortices) than does an equally large curve within the earth. From this it appears that when the unit vortex in these higher latitudes emerges from the earth it converges slightly toward the line of the earth's axis.

If we assume that an extraordinarily rarified atmosphere also exists in interplanetary space, then the earth's rotation must influence this interplanetary atmosphere and to a rather considerable distance from the earth. This influence decreases continually with increasing

distance from the earth until upon reaching some definite point it disappears entirely. Every closed curve embracing the earth at this latter distance has a zero circulation, whence it may be concluded that all the terrestrial vortex filaments are closed curves and have approximately the forms shown in figure 31.

(C.) As our third example let us determine the number and arrangement of the unit vortices in a tornado. Wegener states [1] that—

At a distance of but a few hundred meters from the axis of a tornado the atmosphere is characterized by calms or by the generally prevailing normal undisturbed winds of the region. In particular do the observations contradict the assumption that a tornado is located practically in the vertical surface bounding two air currents having opposite directions. The movements of the air in the immediate vicinity of the tornado remain quite unaffected by its proximity.

If then a closed curve be drawn about a tornado at some distance from it, the circulation of this curve is zero. It may then be concluded that every tornado consists of two equal systems of unit vortices having opposite directions of rotation. Obviously these two equal systems are made up of the same unit vortices, the latter being recurvėd at the upper limiting level as shown in figure 32.

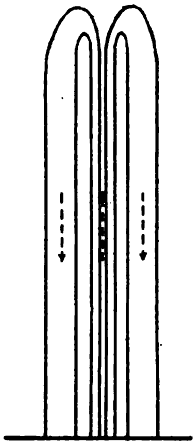

FIG. 32.—The vortex threads of a tornado.

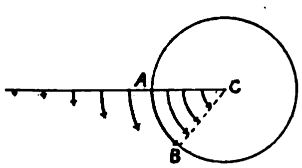

FIG. 33.—The movement of the air in a tornado, according to Wegener.

Wegener's conception of the air movement in a horizontal section through a tornado is shown in figure 33. The relative lengths of the arrows indicate the relative wind velocities. All the vortex filaments between the axis, C, of the tornado and the cylindrical surface, AB, rotate in the direction of the tornado itself; beyond the surface, AB, the vortex filaments rotate in the opposite direction.

In order to illustrate how the number of unit vortices in a tornado can be estimated, assume, for example, that the radius CA in figure 33 is 25 m., and the velocity of the air moving along AB is 50 m/sec. Then the circumference of the circle AB is 157 m., and the circulation of this circle must be $50\times157=7{,}850$ m.^{2}/sec., or 78,500,000 cm.^{2}/sec. The cylindrical surface AB therefore incloses 78.5 millions of unit vortices rotating in the direction of the tornado. Outside this cylinder is an equal number of unit vortices, but these rotate in the opposite direction.

[1] Met. Zeit., Mai, 1911, p. 205.

At the upper level, where the vortex filaments of the tornado recurve, the axis of the tornado disappears. In this respect tornadoes resemble the funnel-shaped eddies that anyone can observe at the surface of any stream of water. One may also easily convince oneself that the axes of these water eddies also terminate freely in the water.

§ 19.

The above examples will, I think, suffice to make one so well acquainted with the hydrodynamic vortex theory that the following results and expositions of my observations will be intelligible. My observations have shown that atmospheric vortices are generally of a very simple character, belonging chiefly to the one or the other of two groups, viz, rotating vortices and glide vortices. In the vortices of the former group the vortex filaments are upright or very steeply inclined, while in the latter group they are quite or very nearly horizontal. The glide vortices may transform themselves into rotating vortices, but I have never observed the opposite process.

Generally I have had little difficulty in deducing the direction and the number of the unit vortices. In the case of rotating vortices, I have represented the closed curves by circles whose axes are coincident with the vortex axis, so that the circulation C of these circles may be simply expressed as

$$C=2\pi rv \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where r is the radius of the circle and v the peripheral velocity of its circumference. The unit vortices are arranged parallel to the axis and their number within such a circle is C.

The glide vortices are intimately related to the relative velocity of the air on both sides of the glide surfaces. Therefore we have first to determine the direction and magnitude of these velocities. In figures 34 and 34a let the vectors v_1 and v_2 indicate the direction and magnitude of the air velocity above and below the glide surfaces, respectively; let the vector Δv indicate the relative velocity of the air above the glide plane or surface, with reference to the air below that surface. The direction and magnitude of this Δv vector is obtained by joining the ends of the vectors v_1 and v_2.

The velocities v_1 and v_2 and Δv, when viewed from above, i. e., as they would appear upon a synoptic weather map, are shown in figure 34a. On the other hand when viewed from the side the vertical section would appear as in figures 34b and 34c. The figure 34b shows a vertical section perpendicular to the vector Δv, and figure 34c is a vertical section along Δv. In these vertical sections ABCDA represents a closed curve intersecting the glide surface at the points E and F. In order to ascertain the number of glide vortices

inclosed by this curve we compute its circulation. Evidently the tangential component of the air velocity along the line AB of figure 34b is equal to k, as is it also along the line DC. The tangential component of the velocity along the lines AD and BC is zero. If we integrate the tangential component of the velocity over the whole closed curve ABCDA we obtain the values $+kL$ for the line AB and $-kL$ for the line CD; L being the length of the line AB. The integral for the whole curve ABCDA is therefore zero; that is to say, this curve does not inclose any unit vortex. This must indicate that the vortex filaments lie parallel to the plane of the closed curve shown in figure 34b, and are therefore perpendicular to the vector Δv.

In figure 34c the integral of the line AB is k_1L, and for the line CD it is k_2L. Hence the circulation of the closed curve ABCDA in figure 34c is—

$$C = (k_1 + k_2)L,$$

But since figure 34a shows that $k_1 + k_2 = \Delta v$, therefore,

$$C = L.\Delta v \quad . \quad . \quad . \quad (3)$$

It is here assumed that L is expressed in centimeters and Δv in cm./sec. If the number of unit vortices per centimeter of the glide surface be represented by c then—

$$c = \Delta v \quad . \quad . \quad . \quad . \quad (4)$$

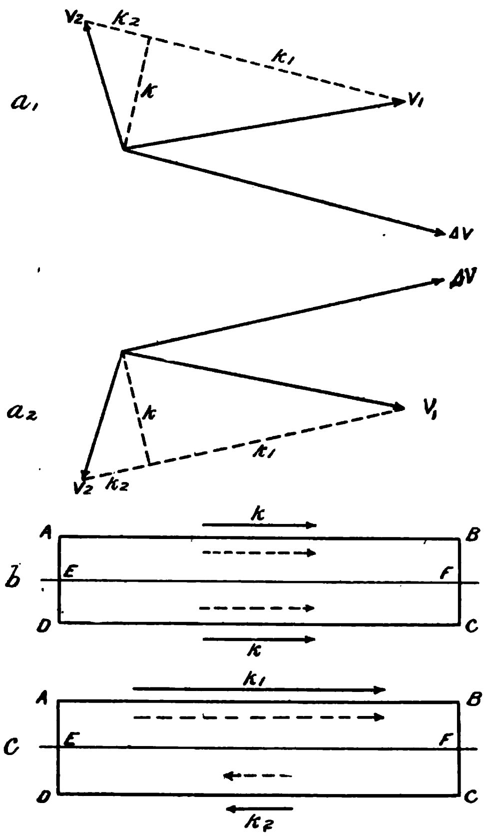

FIG. 34.—Derivation of a glide vortex from the relative velocity of two superposed layers of air.

that is to say, *the number c of unit vortices per centimeter of the glide surface normal to the direction of the vortex filaments equals the relative velocity Δv of the air on either side of the glide surface.*

§ 20.

The hydrodynamic vortex theory has been very completely developed for the case of ideal fluids. Such fluids are frictionless and either incompressible or so constituted that their density is a function of the pressure only. However, in nature we never meet with such

fluids. In my observational study of the vortex movements in the atmosphere I have therefore set myself the special problem of determining the extent to which the laws deduced for ideal fluids hold good for atmospheric air, and of determining what changes are called for in those cases where these laws do not apply.

My first observations related to the influence of friction on the form of the vortex filaments [which I now call *vortex threads* C. A.]. It appeared that friction wrought a simplification in their form, since the property of vortex filaments to terminate at the boundary of the ideal fluid is not a characteristic of the vortex threads in the cases of the atmosphere or of water. This change is due to the fact that in both of these fluids some of the fluid adheres to the bounding surface, so that no true glide surface exists at the boundary. On the contrary, within the limits of a thin sheet of fluid at the boundary there is a steady change of velocity from that of the contiguous vessel, wall, or other medium, to that of the free fluid. This peculiarity of motion leads us to the important law: *All the vortex threads of the atmosphere and of water or other liquids are closed curves.*

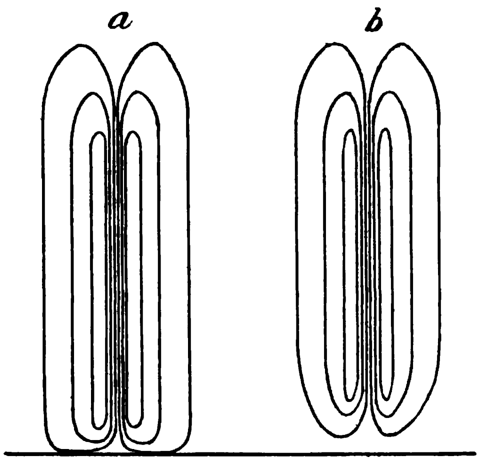

FIG. 35.—Arrangement of the vortex threads of a tornado.

The only exceptions to this rule are the fixed vortex filaments emerging from the earth as the result of its diurnal rotation.

Another effect of friction is seen in the slight blurring of those glide surfaces that occur within the atmosphere, so that the associated vortex filaments are like thin layers of vortex threads rather than surfaces. Further, friction seems to aid in transforming glide vortices into rotating vortices. Finally, friction may serve to increase as well as to diminish the intensity of a vortex thread. However, this effect seems to be rather slight in comparison with the magnitudes of the other forces at work producing or destroying atmospheric vortices.

As illustrations of the effect of friction, some examples are here presented.

(A.) Friction changes the arrangement of the vortex filaments of a tornado from that shown in figure 32, distorting them into the arrangement of figure 35a. When the tornado makes one of its characteristic leaps, then the vortex threads assume the arrangement shown in figure 35b.

(B.) In the case of the funnel-shaped vortex of water, such as may be found at the surface of every stream, the adjacent air touching the water is carried along with it and partakes of its motion. Thus, because of friction, there is formed an air vortex above the water vortex and the vortex lines emerging from the water are continued up into the air, as shown by figure 36.

(C.) The development of whirling vortices from glide vortices, by reason of friction, takes place when one makes an oar stroke in water, or a similar short stroke with a spoon in a cup of coffee. Here again, a vortex forms in the air above the liquid, so that there results a closed vortex-ring as shown in figure 37.

(D.) Since the vortex threads have this property of recurving upon themselves it is unavoidable that small portions of the glide vortex should at times assume a vertical position. It is in this upright position that rotating vortices are most likely to form. Such is the

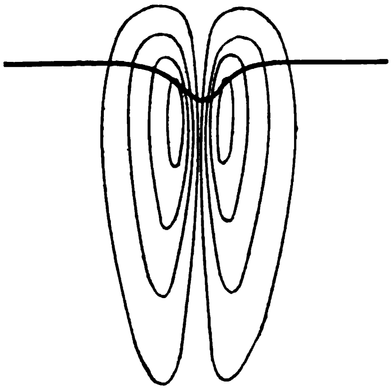

FIG. 36.—Vortex threads of a funnel-shaped vortex in water.

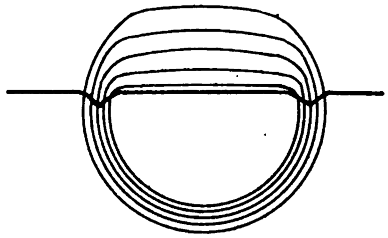

FIG. 37.—The vortex ring formed by the stroke of an oar in water.

case when a mass of heavier or denser air of greater specific gravity pushes in beneath lighter air. In this way, for example, thunderstorms and squalls may originate, as was suggested by Wilhelm Schmidt,[1] who by very instructive experiments has made his theory quite probable. Such an advancing tongue-shaped mass of air is surrounded by glide vortices somewhat after the manner represented in figure 38, which shows the closed curve of this vortex in cross section.

Applying the law of signs to this glide vortex, we find that the vortex threads on the left-hand side of the current of air are directed upward and those on the right-hand side are directed downward, as shown by the curved dotted arrows of figure 38. The dotting of

[1] Schmidt, Wilh.: Gewitter und Böen, rasche Druckanstiege. K. Akad. Wiss., Wien, Math.-Naturw Kl., Bd. 119, Abt. II. A., Wien, 1910.
Schmidt, Wilh.: Zur Mechanik der Böen. Met. Zeit., Braunschweig, August, 1911. 22 Bd., p. 355.

the arrows reminds us that they indicate the directions of the vortex threads and not the direction of the air current. Now, in consequence of the earth's rotation, vortices also emerge from the earth, and these are directed upward on the Northern Hemisphere. In figure 38 the straight vertical solid lines represent these emerging vortices and the straight vertical dotted arrows indicate their direction. On the left side of the air current both systems of vortices are directed upward, and therefore mutually reenforce each other. On the right-hand side, however, the two systems have opposite directions, and therefore largely counteract each other. For this reason tornadoes develop on the left-hand side only of the thunder squalls and whirl in a counterclockwise or cyclonic direction. On the left of figure 38 is figured one of the independent vortices, or tornadoes, given off by the glide vortex.

In the Southern Hemisphere, where the terrestrial vortex threads are directed downward, tornadoes arise on the right-hand side of the air current, and the central vortex threads of these southern tornadoes are also directed downward.

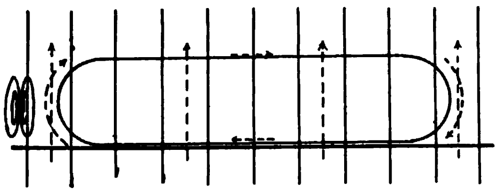

Fig. 38.—Vortex threads of a thunder squall.

It might be thought that the rotation of the tornadoes as well as of the cyclones is produced wholly by the earth's rotation. Table 2 shows that in consequence of the earth's rotation there emerge from within the earth and at latitude 60°, 1.263 unit vortices per square meter of the earth's surface. *It would be necessary to concentrate the air from a region of 62 square kilometers, which contains* 78.5×10^6 *unit vortices, into one tornado in order to form the tornado mentioned above*—an unlikely occurrence. It appears that the earth's rotation is probably too slow to produce tornadoes in this direct manner.

§ (21).

According to the hydrodynamic vortex theory the intensity of the vortex remains constant in an ideal fluid, so that the circulation of every curve composed of particles of an ideal fluid also remains constant. For the purpose of determining the necessary changes in this law when it is applied to natural fluids, and particularly atmospheric air, I made very careful observations on the variations in the intensity of atmospheric vortices. These observations showed that the intensity of a whirling vortex remains very constant, while it varies greatly in a glide vortex. I established the following law for the variation of intensity in glide vortices:

When there is a glide surface in the atmosphere and when the relative velocity of the air above this glide surface has an upward component with reference to the air beneath that surface, then the intensity of the glide vortices increases; but if the relative velocity of the overlying air has a downward component, then the intensity of the glide vortices decreases.

My observations made in Swedish mountains on the wave motions in atmospheric glide surfaces lead me to the conclusion that very stable atmospheric conditions always prevail in the vicinity of such surfaces, for the air above them is specifically lighter than that below. I observed, further, that the glide surface is accentuated by the air movement in the vicinity, thereby tending to limit the obliterating influence of friction on the movement of the air.

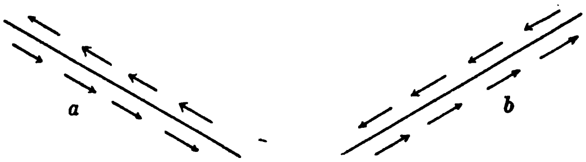

FIG. 39.—Currents near a glide surface.
a, increasing intensity of vortices; *b*, decreasing intensity of vortices.

In order to explain this result of observation we must consider the air movement and the pressure distribution in the vicinity of the glide surface. Figure 39 presents the air movement in the vicinity of two obliquely placed glide surfaces. In figure 39 *a*, the relative velocity Δv of the air above with reference to the air below the glide surface has an ascending component. Here the vortex intensity is increasing in accordance with the law just formulated. In figure 39 *b*, this relative velocity of the upper layer is directed downward and the vortex intensity is accordingly decreasing.

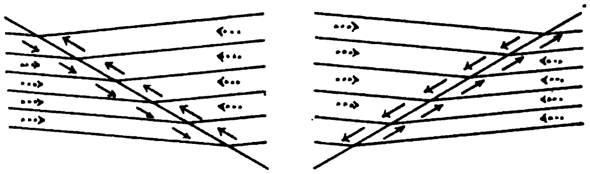

FIG. 40.—Isobars near a glide surface.
Increasing intensity of vortices. Decreasing intensity of vortices.

As air above the glide surface is specifically lighter than that below this surface, therefore the vertical intervals of the same isobaric surfaces are greater above the glide surface than below it. Hence there results a peculiar bend or flexure of the isobars at this glide surface, as seen in figure 40.

The direction of the pressure gradients can easily be deduced from the inclination of the isobars due to this bend at the glide surface. The dotted arrows of figure 40 show this direction. From the diagram, figure 40, there results the simple law that the pressure gradient is *always directed toward the glide surface*. Hence the air is pressed against that surface. Thus it is that the glide surface is accentuated notwithstanding that the friction tends to obliterate it. When one compares the dotted arrows of figure 40 with the solid

arrows in this figure, it appears that the pressure gradient aids this air movement under the conditions as shown by figure 40*A*, and hinders it under those of figure 40 *B*. Hence it follows that the relative velocity is increased in the first case and decreased in the second case. In other words, an increase in relative velocity is equivalent to an increase in the intensity of the glide vortex, and a decrease of the relative velocity is equivalent to a decrease of this intensity. This increase or decrease in the intensity of the glide vortex is therefore to be explained by the distribution of pressure in the neighborhood of the glide surface.

The amount of the change in intensity of the glide vortex may be conveniently determined by computing the number of unit vortices created or destroyed per second over a given portion *BD* (fig. 41) of the glide surface. For this purpose we employ the construction of figure 41. From the point *D* draw the isobar *DC*, the horizontal *DF*, and the vertical *DA*. Through the point *B* draw the isobar *BA* and the vertical *EBCF*. Finally, from the point *A* draw the

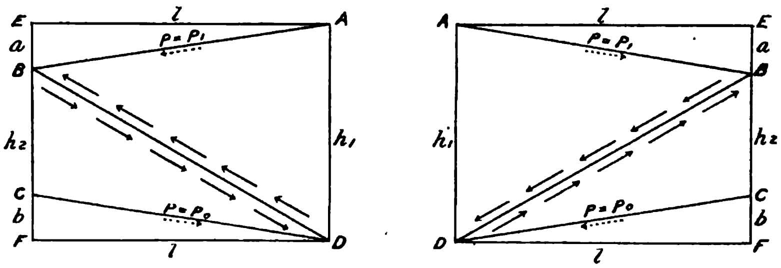

FIG. 41.—Intensity of the glide vortex.

A, increasing. *B*, decreasing.

horizontal *AE*. The distance *A* to *D* is denoted by h_1 in centimeters. Now, $AE = DF = l$; $BE = a$; $BC = h_2$; and $CF = b$. The air pressure along the isobar $DC = p_0$, and along the isobar $AB = p_1$. The solid arrows indicate the movement of the air, and the dotted arrows represent the acceleration of the air due to the distribution of pressure.

The amount of this acceleration may be easily determined. The acceleration per second of the air along the isobar $p = p_0$ in the direction from *C* to *D* will be as though it glided down this inclined plane without friction; therefore it amounts to $\frac{b}{l} \times g$. Similarly, the acceleration per second along the isobar $p = p_1$ is as if gliding from *A* to *B* and amounts to $\frac{a}{l} \times g$. The velocity of the air therefore changes by these amounts each second.

On integrating this change in velocity, all around the curve *ABCDA* there results the actual change per second in the circulation of this curve. The integrals along the verticals *DA* and *BC* can be neglected.

The integral along the line CD equals the product of the acceleration $\frac{b}{l}\times g$ along CD by the length of that line $(=l)$, or bg. Similarly, the integral along AB equals ag. The change in circulation A per second for the whole of the closed curve $ABCDA$ is accordingly $(a+b)g$; but by the construction of figure 41

$$a+b=h_1-h_2;$$

hence

$$A=g\,(h_1-h_2) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

This quantity A is therefore the number of unit vortices developed or annulled each second within the curve $ABCDA$. But since the vertical movement is limited to the glide surface DB, therefore A represents the number of unit vortices developed or annulled each second within the part DB of the glide surface.

For example, if above the glide surface the vertical interval between two isobaric surfaces, $p=p_0$ and $p=p_1$, is 1 centimeter more than below it, then it follows from equation 5 that 981 unit vortices will develop per second in that part of the glide surface included between these isobars. If the difference amounts to 1 meter, then 9,8100 unit vortices will form per second, and if it amounts to H meters, then 9,8100 H unit vortices will form each second. Equation 5 may be written in the following very simple form:

$$A=9{,}8100\,H \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

The quantity A may also be determined by the aid of the specific gravity of the air on the two sides of the glide surface. Let the specific gravity of the air above the glide surface be denoted by q_1 and that of the air below by q_2, then the vertical intervals h_1 and h_2 between the isobaric surfaces are inversely proportional to the specific gravities, i. e.,

$$h_1/h_2=q_2/q_1,$$

whence

$$h_1-h_2=h_1\frac{q_2-q_1}{q_2}.$$

Substituting this value of h_1-h_2 in 5, we have

$$A=gh_1\frac{q_2-q_1}{q_2},$$

or

$$A=gh_2\frac{q_2-q_1}{q_1}.$$

In practical applications of this formula it has been found expedient to substitute for it the following approximation:

$$A=2g\left(\frac{h_1+h_2}{2}\right)\frac{q_2-q_1}{q_2+q_1}$$

or, writing

$$(h_1+h_2)/2=h,$$
$$(q_1+q_2)/2=q,$$
$$q_2-q_1=\Delta q,$$

we have

$$A=gh\frac{\Delta q}{q} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

In equation 7, h may be taken as the vertical difference in altitude of the two points D and B (fig. 41) of the glide surface. On dividing equation 7 by l (the distance between these two points) we obtain the number of unit vortices that are developed per second on each centimeter of the glide surface, i. e.,

$$a=\frac{\Delta q}{q}\, g \sin \alpha \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

This quantity, a, will be called the "intensity increment" of the glide vortex. Equation 8 shows that a is equal to the ratio between the difference in density, Δq, and the mean density, q, of the air masses on either side of the glide surface, DB, multiplied by the component of gravity, $g \sin \alpha$, in the plane of the glide surface. The vertical distances h_1 and h_2 of the isobaric surfaces $p=p_0$ and $p=p_1$ are also directly proportional to the mean virtual temperature T_r of the air at these verticals. This leads us to the equation

$$A=gh\times\frac{\Delta T_r}{T_r} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

where

$$\Delta T_r=T_{r1}-T_{r2}$$

$$a=\frac{\Delta T_r}{T_r}\cdot g \sin \alpha \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

The virtual temperature T_r may be readily obtained with the aid of Table 3.

The significance of the "virtual temperature" is as follows: The density of dry air, q, is given by the well-known formula

$$q=p/RT \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

This formula for q becomes much more complicated for moist air. But since moisture has but a slight influence upon the density of the air, the correction T_r-T, which is a function of pressure, temperature and moisture, may be added to the temperature T, so that the equation 11 computed with the corrected temperature T_r will give the correct density for moist air also. The influence of pressure upon this correction is so slight that pressure may be replaced by the altitude above sea level. Moreover, the correction is proportional to the relative humidity. These circumstances have greatly aided in tabulating the values of the correction; in fact, they were tabulated simply for saturated air. Table 3 presents these corrections as functions of pressure (i. e., altitude) and temperature.

TABLE 3.—*Difference $T_v - T$ between the virtual and the actual temperatures of saturated air at any altitude.*

Altitude above sea.	Temperature, centigrade.												
	−50°.	−40°.	−30°.	−20°.	−15°.	−10°.	−5°.	−2°.	0°.	+1°.	+2°.	+3°.	+4°.
Meters.	°	°	°	°	°	°	°	°	°	°	°	°	°
10,000	0.0	0.0	0.1	0.4	.....	.....	.....	.....	.....	.....	.....	.....	.....
9,500	0.0	0.0	0.1	0.4	.....	.....	.....	.....	.....	.....	.....	.....	.....
9,000	0.0	0.0	0.1	0.3	.....	.....	.....	.....	.....	.....	.....	.....	.....
8,500	0.0	0.0	0.1	0.3	0.5	.....	.....	.....	.....	.....	.....	.....	.....
8,000	0.0	0.0	0.1	0.3	0.5	.....	.....	.....	.....	.....	.....	.....	.....
7,500	0.0	0.0	0.1	0.3	0.4	0.7	.....	.....	.....	.....	.....	.....	.....
7,000	0.0	0.0	0.1	0.2	0.4	0.6	.....	.....	.....	.....	.....	.....	.....
6,500	0.0	0.0	0.1	0.2	0.4	0.6	1.0	.....	.....	.....	.....	.....	.....
6,000	0.0	0.0	0.1	0.2	0.4	0.6	0.9	1.2	.....	.....	.....	.....	.....
5,500	0.0	0.0	0.1	0.2	0.3	0.5	0.8	1.1	1.3	.....	.....	.....	.....
5,000	0.0	0.0	0.1	0.2	0.3	0.5	0.8	1.0	1.2	1.3	1.4	.....	.....
4,500	0.0	0.0	0.1	0.2	0.3	0.5	0.7	0.9	1.1	1.2	1.3	1.4	1.5
4,000	0.0	0.0	0.1	0.2	0.3	0.4	0.7	0.9	1.0	1.1	1.2	1.3	1.4
3,500	0.0	0.0	0.1	0.2	0.3	0.4	0.6	0.8	1.0	1.0	1.1	1.2	1.3
3,000	0.0	0.0	0.1	0.1	0.2	0.4	0.6	0.8	0.9	1.0	1.1	1.1	1.2
2,500	0.0	0.0	0.0	0.1	0.2	0.4	0.6	0.7	0.9	0.9	1.0	1.1	1.2
2,000	0.0	0.0	0.0	0.1	0.2	0.3	0.5	0.7	0.8	0.9	0.9	1.0	1.1
1,500	0.0	0.0	0.0	0.1	0.2	0.3	0.5	0.6	0.8	0.8	0.9	0.9	1.0
1,000	0.0	0.0	0.0	0.1	0.2	0.3	0.5	0.6	0.7	0.8	0.8	0.9	1.0
500	0.0	0.0	0.0	0.1	0.2	0.3	0.4	0.6	0.7	0.7	0.8	0.8	0.9
0	0.0	0.0	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.7	0.8	0.8

Altitude above sea.	Temperature, centigrade.												
	+5°.	+6°.	+7°.	+8°.	+9°.	+10°.	+11°.	+12°.	+13°.	+14°.	+15°.	+16°.	+17°.
Meters.	°	°	°	°	°	°	°	°	°	°	°	°	°
4,500	1.6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4,000	1.5	1.6	1.8	1.9	2.0	.....	.....	.....	.....	.....	.....	.....	.....
3,500	1.4	1.5	1.6	1.8	1.9	2.0	2.2	2.3	2.5	2.7	.....	.....	.....
3,000	1.3	1.4	1.5	1.6	1.8	1.9	2.0	2.2	2.3	2.5	2.7	2.9	3.1
2,500	1.2	1.3	1.4	1.5	1.7	1.8	1.9	2.1	2.2	2.4	2.5	2.7	2.9
2,000	1.2	1.3	1.3	1.4	1.6	1.7	1.8	1.9	2.1	2.2	2.4	2.5	2.7
1,500	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.1	2.2	2.4	2.5
1,000	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2.0	2.1	2.2	2.4
500	1.0	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2.0	2.1	2.2
0	0.9	1.0	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2.0	2.1

Altitude above sea.	Temperature, centigrade.												
	+18°.	+19°.	+20°.	+21°.	+22°.	+23°.	+24°.	+25°.	+26°.	+27°.	+28°.	+29°.	+30°.
Meters.	°	°	°	°	°	°	°	°	°	°	°	°	°
3,000	3.3	3.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2,500	3.1	3.3	3.5	3.7	4.0	4.3	4.6	.....	.....	.....	.....	.....	.....
2,000	2.9	3.1	3.3	3.5	3.8	4.0	4.3	4.6	4.9	5.2	5.5	5.9	.....
1,500	2.7	2.9	3.1	3.3	3.5	3.8	4.0	4.3	4.6	4.9	5.2	5.5	5.9
1,000	2.6	2.7	2.9	3.1	3.3	3.5	3.8	4.0	4.3	4.6	4.9	5.2	5.5
500	2.4	2.6	2.7	2.9	3.1	3.3	3.5	3.8	4.0	4.3	4.6	4.9	5.2
0	2.3	2.4	2.6	2.7	2.9	3.1	3.3	3.6	3.8	4.0	4.3	4.6	4.8

TABLE 3.—*Difference T_t— T between the virtual and the actual temperatures of saturated air at any altitude*—Continued.

Altitude above sea.	Temperature, centigrade.												
	+31°.	+32°.	+33°.	+34°.	+35°.	+36°.	+37°.	+38°.	+39°.	+40°.	+41°.	+42°.	+43°.
Meters.	°	°	°	°	°	°	°	°	°	°	°	°	°
1,500	6.2	6.7	7.1	7.5	......	......	......	......	......	......	......	......	......
1,000	5.9	6.2	6.6	7.1	7.5	7.9	8.4	9.0	9.5	......	......	......	......
500	5.5	5.8	6.2	6.6	7.0	7.4	7.9	8.4	8.9	9.4	10.0	10.6	11.2
0	5.2	5.5	5.8	6.2	6.6	7.0	7.4	7.9	8.3	8.8	9.4	9.9	10.5

Altitude above sea.	Temperature, centigrade.					
	+44°.	+45°.	+46°.	+47°.	+48°.	+49°.
Meters.	°	°	°	°	°	°
500	11.9	12.6	13.3	14.1	14.9	15.8
0	11.1	11.8	12.5	13.2	14.0	14.8

In order to obtain $T_r - T$, one simply multiplies the value for saturated air as determined from this table by the percentage of relative humidity. The table 3 embraces the corrections for all cases that are likely to occur in the atmosphere.

Equation 10 has proved very useful, e. g., in deriving the change in intensity of the glide vortex from the inclination of the glide surface as well as from the distribution of temperature and moisture in the neighborhood of this surface.

By equation 4 § (19) the number of unit vortices per centimeter of the glide surface is

$$c = \Delta v \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

where Δv is the relative velocity of the air on the two sides of the glide surface. If at any instant t_0 the number of unit vortices is

$$c_0 = \Delta v_0,$$

and if after an interval of 1 second, i. e., at the moment $t_0 + 1$, the number is

$$c_1 = \Delta v_1,$$

then the increase in the number of unit vortices, as well as the increase in the relative velocity during this second, is

$$c_1 - c_0 = \Delta v_1 - \Delta v_0.$$

Evidently now

$$c_1 - c_0 = a,$$

and therefore from equation 8

$$a = \Delta v_1 - \Delta v_0 = \frac{\Delta q}{q} . \, g \sin \alpha \quad . \quad . \quad . \quad . \quad . \quad (12)$$

hence from equation 10

$$\Delta v_1 - \Delta v_0 = \frac{\Delta T_r}{T_r} . \ g \sin \alpha \quad . \quad . \quad . \quad . \quad . \quad (13)$$

By means of these two formulæ one may compute the change in the relative velocity, from the distribution of the density (or the temperature and humidity), in the neighborhood of the glide surface.

Conversely, if we have direct observations of the air movement, and wish to compute the distribution of density, or temperature, we make use of the following transformations of 12 and 13, viz:

$$\frac{\Delta q}{q} = \frac{\Delta v_1 - \Delta v_0}{g \sin \alpha} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (14)$$

$$\frac{\Delta T_r}{T_r} = \frac{\Delta v_1 - \Delta v_0}{g \sin \alpha} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

It is not the actual density or temperature that is thus deduced from the air movement, but only the ratio between the difference of density or of temperature on either side of the glide surface referred to the average value of this density or temperature. Notwithstanding this limitation, these formulæ were often very useful to me, and particularly in investigations as to the connection between the phenomena of motion in the atmosphere and the causes that produced them.

In my dynamico-meteorological observations among Sweden's mountains the quantity "c" has been frequently employed, designating it simply as the "intensity of the glide vortex." Although it is very different from the hydrodynamic concept of the "intensity of a vortex filament," yet there seem to be good practical grounds for retaining permanently, this provisional designation for "c" and recommending it for future use. At the same time we must sharply distinguish between the two expressions. The "intensity of a vortex filament" is a differential; the "intensity of a glide vortex" has, on the contrary, a finite value. The two concepts have only one feature in common, viz, the fact that each is proportional to the circulation of the closed curve that surrounds it and that each changes in proportion to the changes in this circulation.

The application of formulæ 8 and 10—15 is greatly facilitated by the use of Table 4.

TABLE 4.—*Values of g sin α.*

	0°.	1°.	2°.	3°.	4°.	5°.	6°.	7°.	8°.	9°.
0°	0	17	34	51	68	86	103	120	137	153
10°	170	187	204	221	237	254	270	287	303	319
20°	336	352	368	383	399	415	430	445	461	476
30°	491	505	520	534	549	563	577	591	604	618
40°	631	644	657	669	682	694	706	718	729	741
50°	752	763	773	784	794	804	813	823	832	841
60°	850	858	866	874	882	889	896	903	910	916
70°	922	928	933	938	943	948	952	956	960	963
80°	966	969	972	974	976	977	979	980	980	981

In illustration let us assume that the stratum of air below the glide surface has a velocity of 5 meters per second in one direction, and that the air stratum above the glide surface moves 10 meters per second in the opposite direction. Then the relative velocity $\Delta v =$ 15 m/sec. or 1,500 cm/sec. It follows from equation 4 that per centimeter of the glide surface there are 1,500 unit vortices at right angles to the vortex threads, i. e., the intensity "c" of this glide vortex is 1,500.

In order to determine whether this intensity is increasing or diminishing, we must determine whether the glide surface is inclined or horizontal. If horizontal, there is no change going on, and the intensity continues steady at 1,500. If inclined and if the inclination of the surface is such that the upper current has an ascending component and the lower current a descending component (as in fig. 41A), then the intensity of the glide vortex is increasing. Suppose that the glide surface is inclined at an angle of 10°; that the temperature t of the lower current is 6.2° C, that that of the upper current is 8° C; that the relative humidity of the lower current is 58 per cent, that that of the upper current is 84 per cent; and that the altitude of the glide surface is 1,500 meters above sea level. It then follows from Table 3 that for saturated air in the lower current $T_r - T$ would be 1°.2, but it is 0°.7 when $r = 58$ per cent; for saturated air in the upper current $T_r - T$ would be 1°.4, but it is 1°.2 for $r = 84$ per cent. Accordingly the virtual temperature for the lower current $6°.2 + 0°.7 = 6.9°$, and for the upper current $8°.0 + 1°.2 = 9.2°$. From Table 4, for $\alpha = 10°$, we have $g. \sin \alpha = 170$. Thus the mean value of $T_r = 273° + \frac{6°.9 + 9°.2}{2} = 281.1°$; and $\Delta T_r = 9°.2 - 6°.9 = 2.3°$. On substituting these values in Equation 9 we obtain

$$a = 1.39,$$

that is to say, the intensity of the glide vortex increases at the rate of 1.39 per second.

If the intensity of the glide vortex is 1,500 at any moment, then after a lapse of one second it amounts to 1,501.39; at the end of a minute it is 1,583.4; and after an hour it is 6,500. The relative velocity of the upper current in reference to the lower current, or Δv, correspondingly increases in one second by the quantity 1.39 cm/sec. It is 15 m/sec. at the start (since the intensity is assumed 1,500); it is 15.0139 m/sec. at the end of one second; 15.834 m/sec. after 1 minute; 65 m/sec. after 1 hour has elapsed.

But if the glide surface is so inclined that the upper current has a descending component and the lower current has an ascending component, as indicated in figure 41B, then the intensity of the glide vortex decreases. Assume as before $\alpha = 10°$, $t = 6.2°$ and 8°, $r = 58$

per cent and 84 per cent for the upper and lower currents, respectively. Then the intensity of the glide vortex decreases at the rate of 1.39 per second and hence the relative velocity Δv diminishes by 1.39 cm/sec. in every second. With an initial relative velocity of 1,500 cm/sec. this will after 1 second then become 1,498.61 cm/sec.; after 1 minute it becomes 1,416.6 cm/sec.; and zero cm/sec. after 18 minutes. Therefore at this instant the velocity has become identical on both sides of the glide surface. After this the relative velocity increases in the opposite direction, so that 1 hour after the initial instant (or 42 minutes after the relative velocity was zero) it will amount to 35 m/sec.

For the second illustration let us, from the increase in the velocity of the air of a snowstorm, compute what quantity of snow is mixed with a cubic meter of that air. When the wind blows across a mountain ridge that is covered with loose, dry snow, it whirls this snow up into the air. By reason of the high specific gravity of this snow-filled air it is opposed to ascending the slope; but after it has reached the summit and begins to descend the other slope it soon attains a great velocity. At the summit and on the wind-protected leeward slopes its velocity is greatly accelerated. Let us assume the velocity of the snow-filled air to increase from 10 m/sec. to 40 m/sec. within 5 minutes, i. e., an acceleration of 10 cm/sec. per second. Since the clean air above the snow-filled air can not take part in this acceleration, therefore the relative velocity of the latter is increased by 10 m/sec. per second, with respect to the former. Hence in equation 14 we have

$$\Delta v_1 - \Delta v_0 = 10.$$

If the slope of the mountain side is 30°, then by Table 4

$$g \sin \alpha = 491$$

so that from formula (14) we get

$$\frac{\Delta q}{q} = 0.020.$$

From this it follows that if a cubic meter of air in the vicinity of the snowstorm weighs 1 kilogram, there are 20 grams of snow mixed in with it. If the cubic meter of air weighs 1.2 kilograms, then it contains 24 grams of snow; if the air weighs but 0.8 kilogram it contains 16 grams of snow. Thus a relatively small quantity of snow suffices to produce the terrible snowstorms encountered in the highlands of Sweden.

§ (22)

I have made this detailed study of these glide vortices and their intensity-changes because of their very intimate relation to the transformations of energy occurring in the atmosphere. The process

whereby in the atmosphere heat is transformed into atmospheric motion is to a certain extent comparable with the process seen in a steam engine. We may distinguish certain regions in the atmosphere that correspond to the boiler, and other regions that act as the condenser. The intermediate region is that which corresponds to the steam engine itself. *The atmospheric mechanism corresponding to the engine is the glide surface.*

In a steam engine the liquid or gaseous water is confined in metallic vessels whose walls serve to maintain it at the proper pressure. There are no such rigid walls in the atmosphere, if we disregard the earth's surface; in the free air gravity alone opposes the pressure of the gas. Therefore the energy that is stored up in the boiler of the steam engine in the form of compressed water vapor returns to the atmosphere only as potential energy. In the atmosphere, therefore, heat is first transformed into potential energy, and then this into the kinetic energy of motion. The glide vortex plays a fundamental rôle in this transformation of potential into kinetic energy.

Under the circumstances illustrated by figure 39 *a*, the vortex-intensity—i. e., the relative velocity of the air—increases; therefore kinetic energy is evolved in the shape of wind. Under the circumstances illustrated by figure 39 *b*, the vortex intensity and with it the relative velocity of the air, decreases. Here kinetic energy is consumed. The question now arises, What is the source of the kinetic energy evolved in the first case, and what becomes of this energy in the second case?

Upon close consideration of the construction of these figures it becomes apparent that the indicated transfers of air must result in diminishing the slope of the glide surface in the first case, making it more nearly horizontal, but in increasing this slope in the second case, making it more nearly vertical. This indicates a decrease of the potential energy of the system in the first case, and an increase in the second. Hence we may conclude that in the air movement indicated in figure 39 *a* potential energy is converted into kinetic, while the opposite process takes place under the conditions of figure 39 *b*.

In order to determine the amount of energy thus transformed consider the diagrams of figure 41. Let the masses of air flowing each second in the upper and lower currents of figure 41 be respectively m_1 and m_2. The amount of energy transformed per second between the points B and D of the glide surface are, respectively, in the upper current

$$e_1 = m_1 g(h_1 - h_2) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (16)$$

and in the lower current

$$e_2 = m_2 g(h_1 - h_2) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (17)$$

Upon comparing these expressions with equation 5 there result the very simple expressions [1] for the energy

$$e_1 = m_1 A \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (18)$$

$$e_2 = m_2 A \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (19)$$

where A is the number of unit vortices evolved each second over the portion $B\ D$ of the glide surface.

In illustration, let us consider the atmospheric mechanism whereby the warmth of the North Atlantic Gulf Stream is spread over Europe, thereby giving it its mild winters. It might be remarked that it was, in fact, the study of this very problem that revealed to me the fundamental significance of the glide vortex for the origin of the winds.

In winter, as one steams along the northwest coast of Norway, there is frequent opportunity to observe a peculiar meteorological phenomenon. Fine weather prevails over a narrow strip along the coast, while a heavy bank of cloud is visible out to seaward. Of course coastwise traffic is greatly favored by this fine-weather strip and takes full advantage of it. Throughout this zone of fine weather prevails a cuttingly cold wind (east wind?) so strong that one can scarce stand against it when on deck. The maximum velocity of this wind is attained near the shore, where the water is whipped up into whirls and miniature waterspouts. Evidently the wind here plunges down upon the water from above, and with great force.

Upon leaving the steamer and traveling inland up the mountain slopes on skis, strong head winds oppose progress. This easterly wind is still very strong on the great divide of the Scandinavian Peninsula. But observations of the cloud caps on the highest peaks of the range show that a westerly wind is blowing at those greater altitudes. It is clear that a lively interchange of air between the North Atlantic Ocean and the Continent is taking place above the Scandinavian highlands. This exchange takes place along either side of a glide surface whose altitude above the ground at the divide may be estimated at about 1,000 meters. In fact, at the kite station Vassijaur, it proved almost impossible to raise the kites above that level, evidently because they there encounter a glide surface through which they can not pass, since the wind has opposite directions on the two sides of this surface, and therefore calm must prevail at the glide surface itself. The altitude of this glide surface decreases to the Atlantic Ocean. The air below this surface flows toward the west; above the surface it flows toward the east. Figure 42 shows the glide surface and the two air currents; the scale of altitudes is exagerated.

[1] See Eq. (6).

Suppose that this phenomenon extends along a coastal belt 500 kilometers long, that the lower or westerly current is 1,000 meters deep, with a velocity of 20 m/sec, and that the density of its air is 0.001 (that of water is 1.000). This current of air then delivers a mass of 10^{10} kilograms, or 10^{13} grams of air per second, hence

$$m_2 = 10^{13} \text{ grams.}$$

If the upper current be also 1,000 meters deep, but its velocity only

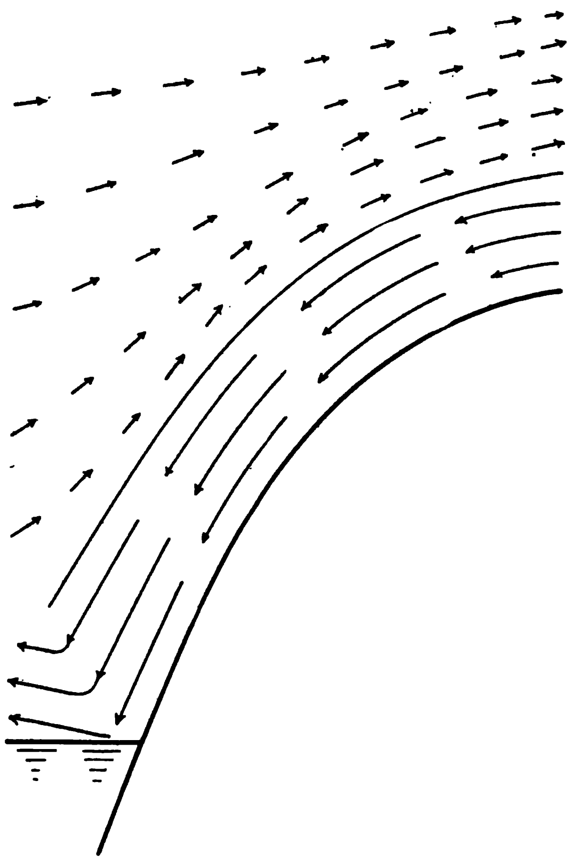

FIG. 42.—The air currents of winter shown by a vertical section normal to the west coast of Norway.

5 m/sec and the density of its air only 0.0008, then the mass of the air that it delivers per second is

$$m_1 = 2 \times 10^{12} \text{ grams.}$$

If the upper current is at the temperature $+4°$ and the lower current temperature $-20°$, the relative humidity of the upper current being 90 per cent and of the lower current 30 per cent, then the virtual temperature of the upper current is $+4.9°$ and of the lower current $-20.0°$; hence the absolute virtual temperatures are 277.9° and 253.0°, respectively.

Thence it results that

$$\Delta T_r = 24.9°$$

and

$$T_r = 265.5°$$

The difference in altitude between the highest and lowest points of the glide surface may be estimated at 1,500 meters, therefore

$$h = 150{,}000 \text{ cm.}$$

now assuming

$$g = 981 \text{ cm/sec}^2$$

it follows by equation (9) that

$$A = 13{,}800{,}000 \text{ unit vortices}$$

are developed each second on this glide surface. The kinetic energy e_1 developed per second by the upper current is found by multiplying this number by

$$m_1 = 2 \times 10^{12}$$

so that

$$e_1 = 276 \times 10^{17}.$$

Similarly $m_2 = 10^{13}$, and the energy per second of the lower current is

$$e_2 = 138 \times 10^{18}.$$

Now one horsepower equals 736×10^7 CGS units. If we divide the above given amounts by this number we obtain the horsepower developed by each of these two currents, viz, for the upper current

$$P_1 = 3{,}570 \text{ million horsepower;}$$

and for the lower current

$$P_2 = 18{,}750 \text{ million horsepower.}$$

The total kinetic energy developed per second at this glide surface is therefore

$$P_1 + P_2 = 22{,}500 \text{ million horsepower,}$$

which is a very considerable amount of energy transformed from heat into wind.

This mighty atmospheric heat engine, which among other things distributes the warmth of the Gulf Stream over Europe, may be approximately described as follows: The air over the Atlantic corresponds to the steam boiler, the air over the Continent acts as the condenser. The glide surface that exists between the Atlantic air and the continental air corresponds to the engine proper and like it is located between boiler and condenser. In the steam engine, heat is converted into motion; just so at the atmospheric glide surface, heat is transformed into wind. The energy developed by a steam engine may be measured in horsepower, and the energy developed at the glide surface may also be measured thus.

The above expositions show that the hydrodynamic vortex theory may be applied with good results in meteorological investigations.

(IV.) ON THE DIURNAL VARIATIONS OF ATMOSPHERIC PRESSURE.

By W. J. Humphreys.

[Dated July 15, 1912.]

INTRODUCTION.

It has been known for nearly two and a half centuries that there are more or less regular daily variations in the height of the barometer, culminating in two maxima and two minima during the course of 24 hours. The phenomenon in question is well illustrated by figure 1, which is a direct copy of a barograph trace obtained, April 1–5, 1912, on Grand Turk Island, latitude 21° 21′ N., longitude 71° 7′ W. It is further illustrated, and shown to persist through all the seasons, by figure 2, which gives, from hourly values, the actual average daily curve for each month, and also for the entire year, as observed at Key West, latitude 24° 33′ N., longitude 81° 48′ W., during the 14 years 1891–1904. In this figure, and for the convenience of any one who may wish to scale off approximate values, the respective average barometric reading is taken as the base of each curve, and lines parallel to the bases are drawn at 0.1 mm. pressure intervals. The actual values are given in the accompanying table.

Average hourly readings of the barometer, 1891–1904, at Key West, latitude, 24° 33′ N., longitude 81° 48′ W.; elevation, 7 meters.

75th Meridian time.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Average.	764.40	764.08	763.55	762.90	761.58	761.80	763.10	762.20	760.90	760.38	763.05	764.34	762.69
1 a. m.	+ .07	+ .15	+.17	+.15	+.12	+.02	+.12	+.15	+.14	+.02	+.05	+ .05	+.10
2 a. m.	— .11	— .05	—.10	—.14	—.14	—.20	—.14	—.10	—.10	—.21	—.16	— .11	—.13
3 a. m.	— .27	— .30	—.38	—.39	—.34	—.38	—.34	—.30	—.35	—.39	—.34	— .31	—.34
4 a. m.	— .37	— .41	—.48	—.45	—.37	—.41	—.39	—.40	—.42	—.46	—.39	— .38	—.41
5 a. m.	— .39	— .38	—.43	—.34	—.29	—.34	—.34	—.35	—.35	—.34	—.36	— .38	—.36
6 a. m.	— .29	— .20	—.20	—.11	—.06	—.13	—.19	—.15	—.15	—.13	—.16	— .26	—.15
7 a. m.	+ .02	+ .13	+.12	+.25	+.27	+.17	+.10	+.15	+.19	+.20	+.17	+ .08	+.15
8 a. m.	+ .40	+ .46	+.31	+.50	+.50	+.45	+.32	+.34	+.44	+.50	+.52	+ .43	+.43
9 a. m.	+ .83	+ .82	+.74	+.72	+.65	+.58	+.50	+.54	+.67	+.78	+.83	+ .84	+.71
10 a. m.	+1.10	+1.05	+.87	+.82	+.70	+.63	+.57	+.66	+.80	+.88	+.96	+1.04	+.83
11 a. m.	+ .98	+1.05	+.89	+.82	+.67	+.65	+.62	+.69	+.77	+.78	+.83	+ .81	+.81
Noon.	+ .54	+ .71	+.68	+.62	+.55	+.55	+.52	+.56	+.56	+.42	+.45	+ .50	+.56
1 p. m.	— .08	+ .18	+.23	+.32	+.29	+.30	+.30	+.31	+.24	—.05	—.11	— .16	+.15
2 p. m.	— .57	— .33	—.20	—.06	—.06	.00	+.05	—.02	—.20	—.46	—.51	— .59	—.26
3 p. m.	— .80	— .68	—.56	—.50	—.44	—.33	—.31	—.40	—.60	—.72	—.77	— .77	—.56
4 p. m.	— .83	— .86	—.84	—.80	—.75	—.59	—.59	—.71	—.86	—.85	—.87	— .84	—.79
5 p. m.	— .73	— .83	—.89	—.90	—.88	—.74	—.72	—.79	—.86	—.77	—.75	— .74	—.79
6 p. m.	— .57	— .71	—.76	—.85	—.85	—.69	—.65	—.71	—.71	—.59	—.54	— .53	—.69
7 p. m.	— .34	— .48	—.50	—.60	—.60	—.41	—.41	—.45	—.42	—.31	—.26	— .26	—.41
8 p. m.	— .01	— .15	—.18	—.21	—.22	—.08	—.11	—.12	—.05	+.07	+.10	+ .05	—.08
9 p. m.	+ .19	+ .10	+.12	+.12	+.04	+.15	+.12	+.15	+.24	+.32	+.30	+ .28	+.17
10 p. m.	+ .32	+ .26	+.36	+.32	+.27	+.33	+.30	+.34	+.39	+.42	+.40	+ .38	+.36
11 p. m.	+ .32	+ .34	+.41	+.37	+.34	+.40	+.35	+.39	+.39	+.40	+.40	+ .38	+.38
Midnight	+ .22	+ .26	+.33	+.30	+.27	+.30	+.30	+.28	+.29	+.25	+.25	+ .23	+.27

Probably the earliest observations of these rhythmical daily changes in the atmospheric pressure were made by Dr. Beale[1] during the years 1664–65, and therefore very soon after the invention, 1643, of the mercurial barometer. Since Beale's discovery the same observation has been made, admired, and puzzled over at every station at which pressure records were kept and studied, but without success in finding for it any adequate physical explanation. In speaking of the diurnal and semidiurnal variations of the barometer, Lord Rayleigh[2] says:

> The relative magnitude of the latter [semidiurnal variation], as observed at most parts of the earth's surface, is still a mystery, all the attempted explanations being illusory.

The difficulty of finding an adequate elucidation of this meteorological mystery, therefore, is fully recognized, and hence it seems worth while to bring together and to consider in a single paper a number of possible causes of barometric variation, many of which doubtless have somewhere previously been discussed by others, since by the process of elimination and selection the problem may at least be reduced to narrower limits, if not fully solved.

It is well known that differences of temperature lead to differences in atmospheric pressure, as is illustrated by the seasonal interchange of high and low barometric areas over the continents and oceans of middle latitudes; the high pressure pertaining in general to the relatively cold region, to the continent during winter and to the ocean during summer, and the low to the region that is relatively warm.

But besides this seasonal ebb and flow in pressure, and similar to it, there are at least two 24-hour variations that also are dependent upon temperature changes. One of these concerns places of considerable elevation, and is marked by a barometric maximum during the warmest and minimum during the coldest hours. The other applies to low, especially sea level, stations and is the reverse of the above in that here the barometric maximum tends to occur during the coldest and the minimum during the warmest hours. Both variations, however, are partially obscured in the actual records by secondary effects, especially as to the hours of absolute maxima and minima; but as they are clearly brought out by harmonic analysis[3] and fully accounted for by obvious physical causes, there is no reason to question their objective reality.

Figure 3, copied from Mr. Bennett's paper, just referred to, illustrates the results of such an analysis. Here the heavy continuous line shows the average actual daily march of the barometer at a low-level station, Washington, D. C., while the light continuous line and the

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[1] Phil. Trans., 9, p. 153, 1666.
[2] Phil. Mag., 29, p. 179, 1890.
[3] Bennett, Monthly Weather Review, 34, p. 528, 1906.

dotted line are a diurnal and a semidiurnal sine curve, respectively, into which the curve of actual pressure change may be resolved, and presumably represent, in the main, real rather than fictitious components. However, as will be pointed out further on in the paper, it does not follow that the real causes of the barometric changes have accurate sine values, nor that the time intervals from maximum to minimum necessarily are equal. Indeed, certain actual departures from these ideal regularities seem highly probable.

DIURNAL CHANGES OF THE BAROMETER.

The first of the changes mentioned above, the one that concerns elevated stations, is due essentially to volume expansion and contraction of the atmosphere caused, respectively, by heating and by cooling. Thus the lower atmosphere over that side of the earth which is exposed to insolation becomes more or less heated, and therefore, because of the resulting expansion, the center of mass of any given column of air, in spite of lateral flow, presently to be discussed, is well nigh correspondingly raised. Conversely, during the night the atmosphere cools and contracts and the center of mass is proportionately lowered. Hence, so far as this effect alone is concerned, a mountain station, 1,000 meters, say, above sea level, will have the greatest mass of air above it when the atmosphere below is warmest or most expanded, and the least when the lower atmosphere is coldest or most contracted—that is to say, this effect tends to produce, at such stations, barometric maxima during afternoons and minima about dawn.

There is, however, another effect resulting from the volume expansion and contraction of the atmosphere to consider, namely, its lateral flow. To this mainly is due, in the author's opinion, that daily barometric change at sea level, as shown by harmonic analysis, the late afternoon minimum and the early morning maximum, that is the counterpart of the high level change.

The expansion and consequent vertical rise of the air on the warming side of the earth, together with the simultaneous contraction and fall of the atmosphere on the cooling side, establishes a pressure gradient in the upper atmosphere directed from the warmer toward the cooler regions, a gradient that must cause a flow (often only an increase or decrease of the existing flow, but none the less real) that leads to maximum pressure at the coldest places and minimum pressure at the warmest, and hence, as is borne out by observation, to greatest pressure changes over continents and least over oceans. But as these antipodal regions are perpetually moving around the earth at the rate of one revolution every 24 hours, there must be a corresponding perpetual flow of air, or change of flow, as above described, in a ceaseless effort to establish an equilibrium which,

since the disturbance is continuous, can never be attained. Further, the direction of this periodic flow of the air—that is to say, whether toward or from a given place—due to the above gradients, must be reversed, on the average, once every 12 hours.

A rough approximation to the maximum velocity of the wind necessary to produce the observed daily range in the barometer can be found by computing the deficit of air, in terms of an atmosphere, on the heated side of the earth and dividing this by a great circumference and by the duration, T, of the wind (12 hours) in one direction.

Now, as is well known, the daily or 24 hour rise and fall of the barometer is about 0.5 mm. in equatorial regions and decreases toward the poles roughly as the square of the cosine of the latitude. Hence the difference in millimeters at any place between the 24-hour maximum and minimum barometer is $\sin^2\theta$, in which θ is the colatitude, and the total deficit on one side is $2R^2\int_0^{\frac{\pi}{2}}\sin^3\theta d\theta=\frac{4}{3}R^2$, in which R is the radius of the earth. That is to say, the barometer averages $\frac{2}{3\pi}$ mm. low everywhere on the heated side of the earth, and $\frac{2}{3\pi}$ mm. high on the cooler side. In 12 hours this distribution over the surface of the earth is interchanged. Hence the maximum velocity, V_m, or the velocity one quarter of the way around the earth from the crest of the wave, assuming the air to move as a whole, is given by the equation $V_m=\frac{8\ R^2}{3\times760\times2\pi R}\times\frac{1}{T}=8$ centimeters per second roughly, or about 0.18 miles per hour.

This of course is only a crude approximation, but it gives the order of the maximum wind velocity necessary and sufficient to produce the observed daily or 24 hour change in the barometer, a velocity that rapidly decreases as the centers of disturbance—places of highest and lowest temperatures—are approached, and which, as we shall see, may be fully accounted for by the pressure gradients due to the diurnal change of temperature.

In the above a difference of 1 mm. is assumed (in accordance with the observations) to exist between the morning and evening readings of the barometer in equatorial regions, and the maximum velocity with which the air must move to account for the atmospheric interchange demanded by the observations has been determined, on certain assumptions, to be about 8 centimeters per second.

We will now consider the problem from the other side, and see what velocity of the atmosphere would follow from the pressure gradients established by daily temperature changes.

Let the daily temperature change be 10° C. at the surface of the earth, but uniformly less and less in proportion to elevation till it

wholly disappears at a height of 1.5 kilometers. If there were no horizontal flow this temperature change would cause the levels of given pressure to average roughly 25 meters higher during the latter part of the afternoon, when the air is most expanded, than in the early morning, when most contracted. Hence also for much of the atmosphere the maximum difference of pressure at the same level would range from 1 mm. to 2 mm. or, say, an average of 1.5 mm.

Now at 0° C. the coefficient of atmospheric viscosity is about 0.00017—that is to say, it requires a force of 17×10^{-5} dyne per square centimeter to cause one layer of atmosphere at 0° C. to move over another at the same temperature 1 centimeter distant with the velocity of 1 centimeter per second.

The resistance due to atmospheric viscosity is nearly independent of density, but increases with increase of temperature. It is also directly proportional to the velocity of the one layer with respect to the other, and inversely proportional to their distance apart.

But as we have just seen we may take the difference in pressure at the same levels between the regions of maximum and minimum temperatures to be equal to the weight of a column of mercury 1.5 mm. high, or about 2×10^{4} dynes per square centimeter. For simplicity we may consider the difference in pressure between two places along a great circle connecting the points of maximum and minimum expansion to be directly proportional to their distance apart. Hence, on this assumption, the pressure gradient, or difference in pressure per centimeter, is 2×10^{-5} dyne per square centimeter. But the mass of a cubic centimeter of air at an elevation of 1 kilometer is roughly 1×10^{-3} grams, and therefore the given pressure, if it had only inertia to overcome, would produce the requisite velocity of 8 centimeters per second in less than 7 minutes.

Hence the final velocity V of a layer of the atmosphere under this pressure depends upon the viscosity only, is soon reached, and is given by the equation

$V=\frac{2L\times10^{-5}}{\times10^{-5}}=\frac{2L}{17}$ centimeters per second, in which L is the distance in centimeters between the two layers of air whose relative velocity is V centimeters per second. But, as explained above, the maximum difference in level between layers of equal pressure is about 25 meters, and therefore the difference in level between layers of equal pressure at either extreme and a half-way point between them may be roughly 12.5 meters. At this half-way point, however, the velocity of the entire atmosphere necessary and sufficient to produce the observed 24-hour changes of the barometer is, as above explained, 8 centimeters per second.

If now 12.5 meters is the proper value of L to substitute in the above equation in order to obtain the velocity of atmospheric flow

that the assumed pressure distribution would produce, it follows that V would equal 147 centimeters per second, or some 18 times the velocity necessary to account for the observed pressure changes.

It must be distinctly remembered, however, that the above ideal pressure distribution is based on the assumption that there is no horizontal flow, whereas horizontal flows must take place, as shown by the readings of the barometer at sea level, and hence the overflow pressure gradients can never rise to anything like the above computed values,—they are all the time giving way, and the faster they rise the more rapidly they must break down as a result of actual overflow.

While the above calculations can do no more than give rough orders of magnitude, they nevertheless indicate that 24-hour temperature changes are sufficient to account for (and presumably therefore actually do account for) the corresponding 24-hour changes of atmospheric sea-level pressure.

SEMIDIURNAL CHANGES OF THE BAROMETER.

It remains now to consider a problem conspicuously presented both by the actual barometric records and by their harmonic analysis—the problem of the half daily or 12-hour cyclic changes of pressure that give, both morning and evening, 10 o'clock maxima and, similarly, both day and night, 4 o'clock minima. These are the approximate hours; the exact hours depend upon season, location, and probably other conditions.

Some of the observed facts in regard to this 12-hour cyclic change of pressure, as shown by the actual values (e. g., actual curve, fig. 3), are:

(*a*) The amplitude is greatest in the Tropics and decreases toward the poles, approximately as the square of the cosine of the latitude.

(*b*) The amplitude is everywhere greatest at equinoxes and everywhere least as solstices.

(*c*) The amplitude is greater at perihelion than at aphelion.

(*d*) The amplitude is greater by day than by night.

(*e*) The amplitude is greatest on clear days and least on cloudy.

(*f*) The day amplitude is greater over land than over water.

(*g*) The night amplitude is greater over oceans than over continents.

(*h*) Over the tropical Pacific Ocean the forenoon barometric maximum is about 1 mm. above and the afternoon mimimum 1 mm. below the general average pressure.

Now, both the daily change in temperature and the resulting change in convection obviously are greater in the Tropics than elsewhere; greater at perihelion than at aphelion; greater during clear than during cloudy weather; greater by day than by night; greater

over land than over water; and greatest when the time of heating and the time of cooling (day and night) are equal, and least when these are most unequal or at the times of solstice. Hence all the above facts of observation strongly favor, if they do not force, the conclusion that the daily cyclic pressure changes are somehow results of daily temperature changes. Nevertheless, in attempting to account for the barometric swings, both the long period or 24-hour swing, and especially the short period or 12-hour swing, it will be desirable to consider separately the sense and magnitude of the pressure changes due to each known probable cause of any pressure variation whatever, since the total effect can be only the resultant of all the individual components, however numerous they may be.

The following list of such causes is incomplete, but presumably it includes all that are of any special importance, as well as some that produce only negligible effects.

1. *The flow of air from warmer toward colder regions or from places where the air is most expanded toward those where it is most contracted.*

As above explained, this action seems to be the essential cause of the 24-hour term in the variation of the barometer, since it operates in such manner as to give the lowest barometer (not absolute, but so far as the 24-hour term is concerned) shortly after the air is most expanded and highest barometer (also with reference only to the 24-hour term) a little after it is most contracted. That is, a maximum near sunrise and a minimum near sunset, and therefore in harmony, both as to time of occurrence and nature of the change, with the results of harmonic analysis. It will also be used further on in connection with the 12-hour term.

2. *Change in weight of a given mass of air due to its change in elevation.*

During clear summer weather the temperature of the air near the surface of the earth changes by 10° C. or more between the coolest and warmest hours of the day. With increase of elevation the average daily change becomes less and practically disappears at an elevation of, roughly, 1.5 kilometers. Over the oceans these changes are of the same kind but less in magnitude.

As a result of the daily temperature changes that occur over land, the center of mass of the atmosphere, if there were no flowing away to the sides, would, when most expanded, be about 25 meters higher over continental areas than it is when coldest and most contracted. Hence the force of gravity on a given column of air, assuming its mass to remain the same, is greatest when the air is coldest and least when it is warmest according to the equation $B'/B = R^2/(R+25)^2$, in which B is the height of the barometer and R the radius of the earth in meters. But the change is so slight that the difference in the height of the barometer, due to this cause alone, amounts to only

about 0.006 mm.; and even this small amount is greater than the actual pressure change due to the particular cause in question, since the horizontal flow to and from the expanding and contracting column necessarily decreases the range through which its center of mass rises and falls.

3. *Change in the centrifugal force as the atmosphere is raised or lowered.*

Let the change in temperature from day to night and consequent change in the elevation of the center of mass be assumed the same in this case as in that above. That is, a temperature change of 10° C. at the surface of the earth gradually decreasing to zero at an elevation of 1.5 kilometers and a resulting change in elevation of the center of mass of 25 meters.

Temperature changes, so far as they raise and lower the atmosphere, must act esssentially as central forces. Hence the air, both when it is raised and when allowed to descend, must tend to change its velocity in such manner and to such an extent as to conform to the law of equal areas; that is to say, so that the radius vector connecting it normally with the axis of rotation will continuously sweep over equal areas in equal intervals of time, or, in other words, so that the linear velocity of a given particle of air shall at all times be inversely proportional to its distance from the axis of the earth. Therefore the linear velocity of the atmosphere as a whole in the direction of rotation must tend to decrease with expansion and consequent lift of its center of mass to a greater elevation and tend to increase with contraction.

Now centrifugal force is directly proportional to the square of linear velocity and inversely proportional to the radius of curvature. But in the case under consideration, assuming the law of equal areas to apply, the linear velocity is also inversely proportional to the radius of curvature and consequently the centrifugal force of the atmosphere is inversely proportional to the cube of its distance from the earth's axis.

Therefore even the assumed change of 25 meters in the elevation of the center of mass of the atmosphere, which, as was explained above, probably is greater than the real change, would alter the reading of the barometer by only about 0.00003 mm.

Changes therefore in the centrifugal forces of the atmosphere, due to variations in the height of its center of mass, would, if the law of equal areas fully applied, cause the barometer to stand lower by only the above negligible amount when the air is coldest than it does when the air is warmest, and by a still smaller amount if the law of areas does not apply.

4. *Waves of condensation and rarefaction due to that change in velocity, incident to convection, demanded by the law of areas.*

As just explained, a given mass of the atmosphere tends, under the influence of central forces, to move in such manner that the line connecting it normally with the axis of the earth shall continually move over equal areas in equal intervals of time. Hence, considering this influence alone, expansion and contraction must cause unequal velocities of flow, and therefore waves of condensation and rarefaction that produce corresponding fluctuations in the barometer.

Consider a region near the Equator and let the atmosphere between two parallels of latitude remain fixed in quantity. Also let the daily temperature change, as above explained, raise and lower the center of mass of the atmosphere 25 meters. Under these conditions the extreme velocities of the atmosphere between the given parallels will tend to be to each other as R to $R+25$, in which R is the equatorial radius of the earth in meters, and the corresponding surface pressures as $R+25$ to R. Hence this cause alone tends to produce a barometric range of about 0.003 mm., the maximum pressure occurring when the air is most expanded and the mimimum when it is most contracted.

The above assumptions, like several others in this paper, probably do not closely conform to the facts. Lateral flow, for instance, will prevent expansion from having its full effect in elevating the center of mass, and besides it is probable that the law of areas does not rigidly apply to masses of the atmosphere since, according to Darwin,[1] there can be no lag between the mean motion of the upper atmosphere and that of the earth, but the assumptions as they stand give the upper or maximum order of magnitude, and thereby show that the influence in question is negligible.

5. *Electrical attraction between the sun and the earth.*

When the electric gradient at the surface of the earth has its approximately average value of 1 volt per centimeter, the force per square centimeter of surface is, as will be shown under heading 11, $\frac{1}{8\pi}$ dynes, approximately. Hence the numerical value of the charge in absolute units per square centimeter is $\frac{1}{4\pi}$.

Now assume the sun to have a surface charge of positive electricity, and let the total value of this charge be 25.5×10^{10} coulombs, or 76.5×10^{19} absolute units, the maximum possible value, according to Arrhenius.[2] This gives an electric pressure on a column of air 1 square centimeter in cross section, when the sun is in the zenith, of

$$\frac{76.5\times 10^{19}}{4\pi\times(1495)^2\times 10^{20}}\text{ dynes}=\frac{1}{367}\times 10^{-4}\text{, nearly.}$$

[1] Phil. Mag., 23, p. 664, 1912.

[2] Terres. Mag. and Atmos. Electric., 10, p. 5, 1905.

This force would increase the height of the barometer by roughly 2×10^{-10} mm., an immeasurably small amount, the increase being a maximum at noon.

6. *Reactions due to inertia of the atmosphere incident to expansion and contraction.*

Again assuming the rise and fall of the center of mass of the atmosphere to be 25 meters, probably an excessive amount, it becomes possible roughly to determine the resulting pressure changes due to inertia. Whatever the convective turmoil, the pressure gain due to acceleration upward is offset by the loss of pressure due to acceleration downward except in so far as the center of mass is actually lifted by expansion, and therefore this effect alone need be considered here. Let this lift of the atmosphere be due to an increase of temperature at such rate as to cause a uniformly accelerated rise of the center of mass, and let it be fully accomplished in the course of eight hours. Reducing to centimeters and seconds we get the equations

$$2500 = \frac{1}{2}a(28800)^2, \text{ and}$$

$$a = \frac{1}{16 \times 10^4}, \text{ roughly,}$$

in which a is the acceleration in question.

Now, the weight per square centimeter surface to be lifted is 1033 grams, approximately. Hence the force f in dynes is given by the equation $f = \frac{1033}{16 \times 10^4} = 0.0065$, nearly.

But since the weight of a cubic centimeter of mercury is about 13×10^3 dynes, the above force f would increase the height of the barometer by only 5×10^{-6} mm. during the warming period, which occurs during the forenoon mainly, and lower it by roughly the same negligible amount during the night or cooling period. And yet it has often been seriously claimed that inertia incident to expansion and contraction of the atmosphere is the real cause of the daily changes in the barometer!

7. *Reaction due to viscosity of rising and falling columns or masses of air.*

A rising column of air has to overcome the viscosity reaction between itself and the adjacent atmosphere through which it is moving, and therefore must exert a correspondingly greater pressure at the surface of the earth. But obviously the same pressure is removed from the surrounding atmosphere, so that on the whole the pressure effect is only such as to produce barometric fluctuations as the rising and falling columns succeed each other.

To form some idea of the possible magnitude of these fluctuations, consider a column of air 100 meters in diameter rising with the veloc-

ity of 3 meters per second, and let the still air be separated 2 meters from the rising column, the intermediate space being filled with air of intermediate rates of ascent. Also let the height of the rising column be half a kilometer.

Obviously the reaction pressure due to viscosity is more or less uniformly distributed over the bottom of a rising column of any fluid. Hence, in the present case, since the coefficient of atmospheric viscosity is roughly 17×10^{-5}, the actual pressure, p, per square centimeter, or at any rate its order of magnitude, is given by the approximate equation

$$p=\frac{2\pi r\times17\times10^{-5}\times3\times10^{2}\times5\times10^{4}}{\pi r^{2}\times2\times10^{2}}=5\times10^{-3}\text{ dynes.}$$

But this would alter the reading of the barometer by only 4×10^{-6} mm., and therefore, since the assumed case was rather an extreme one, it does not seem that measurable fluctuations of the barometer, whatever their period, long or short, can ever be due to atmospheric viscosity.

8. *Changes in amount of air below the level of the barometer.*

The effect of air drainage, operative everywhere except on dead evels, is important in connection with minute daily changes of the barometer; and the level, or elevation, of the barometer itself is also of great importance in this connection.

For the sake of simplicity, consider the case of no air drainage. The height of the homogeneous atmosphere at the uniform temperature of 0° C. and 760 mm. pressure is nearly 8,000 meters. Hence, assuming no lateral flow, the change in the barometric reading per meter above the surface, and per centigrade degree change in temperature, is $\frac{760}{8{,}000\times273}$ mm., or 0.00035 mm., nearly. For the moderate temperature change of 10° C. and elevation of only 3 meters, this is roughly 0.01 mm. For this same change of temperature and an elevation of 100 meters, a level even exceeded in some buildings, this change of pressure amounts to about 0.35 mm.; a very appreciable amount, and quite sufficient to mask, at the higher latitudes, the regular 12-hour cyclic change as recorded on direct reading barographs. Corrections, of course, are applied in such cases, but as these are subject to errors it is best to have the barometer so situated that the corrections will be as small as possible.

9. *Light-pressure on the atmosphere.*

It has been shown that unidirectional radiant energy exerts a pressure on a perfect absorber at right angles to it, whose intensity is numerically equal to the energy density. In other words, the number of dynes radiation pressure per normal square centimeter of the absorbing surface is equal to the number of ergs radiation energy per cubic centimeter of the space in front of the absorber.

In the case of a perfect reflector, at rest with reference to the source of radiation, the pressure is just twice that on a perfect absorber; but when the absorption and reflection are imperfect the resulting light-pressures are correspondingly less.

Now, the radiant energy from the sun amounts at the surface of the atmosphere to about 2 calories, or, say, 84×10^6 ergs per minute, or 14×10^5 ergs per second per square centimeter, and therefore in the case of a perfect absorber the pressure p is given by the equation

$$p=\frac{14\times10^5}{3\times10^{10}}=\frac{14}{3\times10^5}$$

On clear days, and where the sun is in the zenith, the absorption of solar energy by the atmosphere amounts to about .30 per cent, but on cloudy or hazy days to a correspondingly greater fraction. Therefore, since a cubic centimeter of mercury weighs, roughly, 13 by 10^3 dynes, light-pressure on a clear atmosphere, neglecting the counterpressure due to absorption of earth radiation, can increase the height of the barometer by only about 5×10^{-8} mm., or one twenty-millionth of a millimeter, while light-pressure on the cloudiest of atmospheres can raise the barometer at most only 2×10^{-7}, or one five-millionth of a millimeter. This, too, is an upper limit or maximum effect. The actual effect, owing to the counter influence due to the absorption of earth radiation, may not be half so great. In no case, then, is the change of the barometer due to light-pressure a measurable quantity.

10. *Bombardment of the atmosphere by particles from the sun.*

It has been suggested that our auroras and magnetic storms are due to electrons from the sun that impinge upon the outer atmosphere or pass in streams by the earth. However, Schuster[1] has recently shown this theory to be highly improbable. But the possibility of a similar bombardment of unelectrified particles, with resulting auroras and magnetic storms, is not excluded; neither is it certain that such a bombardment ever actually occurs, and of course, therefore, the very existence of a pressure effect due to such a cause is as doubtful as the cause itself.

But in any event the barometric changes due to this bombardment, assuming that it also directly or indirectly causes the auroras and magnetic storms, are not large, since the size of these changes appears to have no relation to either the magnitude or the frequency of either of the other two phenomena.

This possible cause, then, of changes in barometric pressure, since it is either nonexistent or negligibly small, may be dismissed from further consideration.

11. *Electrical attraction between the ground and the atmosphere above it.*

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[1] Proc. Roy. Soc., A, 85, 44, 1911.

The surface of the earth is at all times at a different electrical potential from that of the atmosphere, and consequently there is a corresponding pull between them that must affect the height of the barometer. In determining the magnitude of this pull the surface of the earth and any level in the atmosphere may be treated as oppositely charged concentric spherical surfaces.

Let p be the normal pull in dynes per square centimeter of surface, $\frac{dv}{dn}$ the potential gradient or ratio of change in potential to change in distance from the surface. We can, then, write the equation

$$p=\frac{1}{8\pi}\left(\frac{dv}{dn}\right)^2$$

But the average value of the gradient at the earth's surface is about one volt per centimeter or unity.

Hence, ordinarily

$$p=\text{about } \frac{1}{8\pi} \text{ dynes per square centimeter.}$$

But as the weight of a cubic centimeter of mercury is approximately 13×10^3 dynes, it follows that when the potential gradient has the value of one volt per centimeter the height of the barometer is thereby increased by about $\frac{1}{33,000}$ mm.

Besides irregular disturbances that sometimes amount to reversals of sign, this potential gradient has periodic changes, with commonly two maxima and two minima per day. At Kew, for instance, the minima occur, on the average for the year, at 4 a. m. and 2 p. m., respectively, and the maxima at 9 a. m. and 9 p. m. The average difference between the smallest and largest gradient is about 60 volts per meter, and therefore a change of only $\frac{1}{55,000}$ mm. in the height of the barometer could be accounted for in this way. Hence, though these potential gradient changes are roughly synchronous with the 12-hour changes in the barometer, they can not be regarded as the cause of an appreciable barometric variation. Whether the barometric fluctuations can to any extent account for the electrical charges is of course a different question, but presumably they can not, since at most stations there is not even an approximate synchronism between the two phenomena.

12. *Bombardment of the atmosphere by meteoric material.*

While large meteorites enter the atmosphere only occasionally, smaller ones are of frequent occurrence; and it seems probable that the number so increases with decrease of size that those too small to produce visible streaks are far more numerous and even greater in

total mass than all those combined that may be individually seen. Estimates have been made of the rate at which meteoric material is picked up by the earth, but we may assume, as an upper limit, 3 kilograms per second, an amount sufficient to account for "earth light,"[1] or the lumunosity of the midnight sky in excess of that due to the stars.

This continuous bombardment must produce an increase of atmospheric pressure; greatest at about 6 o'clock in the morning, or on the forward side of the earth in its orbital path where both the number of particles and the velocity of impact are greatest, and least on the opposite side where each of these terms is least.

For simplicity of calculation assume the 3 kilograms per second to be evenly distributed around the earth in masses of molecular dimensions and to enter the atmosphere with the velocity of 42 kilometers per second—the orbital velocity, approximately, at the earth's distance from the sun.

Since, as a first approximation, the particles may be supposed to enter the atmosphere in equal numbers at all angles above the tangent plane, the normal pressure, p, in dynes per square centimeter, is numerically equal to half the energy in ergs per cubic centimeter. Hence

$$p=\frac{1}{2}\,\frac{1500\times(4200000)^2}{4\pi R^2\times 4200000},$$

where R is the radius of the earth in centimeters. Therefore

$$p=6\times 10^{-10}\text{ roughly.}$$

But the weight of a cubic centimeter of mercury is about 13×10^3 dynes, and hence $p=$ a barometric pressure of about 46×10^{-14} mm., a quantity wholly immeasurable by any known means.

13. *Changes of amount of gas contained in water, due to temperature changes.*

Assuming the surface temperature of the ocean to be about 20° C., and its daily change[2] 0.5° C., and using Bunsen's formula[3] for change of the absorption coefficient of air in water with change of temperature, we obtain 6×10^{-5} as the fraction of a cubic centimeter of air absorbed or given off per cubic centimeter of the water whose temperature is decreased or increased by the given amount.

Now, taking the average annual rainfall of the globe to be 84 centimeters, as calculated by Dr. John Murray, it follows that the average daily evaporation from the ocean, allowing but little from the land, is about 3 mm., requiring 1,840 calories per square centimeter. But the average gain and loss of energy per square centimeter of the

[1] Astrophysical Journal, 35, p. 273, 1912.
[2] Krümmel, Handbuch der Ozeanographie, Vol. I, p. 383.
[3] Winkelmann, Handbuch der Physik, Vol. I, p. 1516.

surface of the earth is not far from 0.2 calory per minute, or 2,880 calories per day. Hence 1,000 calories per square centimeter is the amount of energy, roughly, daily gained and lost by the ocean in its alternate heating and cooling, and therefore, if the temperature change is uniformly 0.5° C., it must extend to the depth of 2 meters. In reality these are not the actual values, but, taken together, are the equivalent values.

Hence the amount of gas, at normal temperature and pressure, taken up by the water when it is coldest and given out when warmest is $6 \times 10^{-5} \times 2 \times 10^{2} = 12 \times 10^{-3}$ cubic centimeters per square centimeter of water surface. Now, the height of the homogeneous atmosphere is approximately 8,000 meters, and hence the change in the barometer, at the surface of the ocean, due to the above absorption of the atmosphere is about

$$\frac{760 \times 12 \times 10^{-3}}{8 \times 10^{5}} \text{ mm.} = 10^{-5} \text{ mm., roughly.}$$

So far as this negligibly small term is concerned, the pressure is greatest when the water is warmest and least when it is coolest.

14. *Changes in the volume of the atmosphere due to plant action.*

Since growing plants take up during the day more or less carbon dioxide, and at the same time give off an equal volume of oxygen it follows, because of the difference in density of these two gases, that the total atmospheric pressure should slightly vary through a 24-hour cycle; and this in spite of the fact that, owing to compensating sources, both constituents of the atmosphere remain substantially constant from season to season and from year to year.

The amount of this variation depends of course upon the rate of plant growth, but assuming the yearly growth such as to store up 1 kilogram of carbon per 5 square meters (roughly that of a heavy grain crop), that the growth is uniform throughout the year, and that the consumption of carbon dioxide is by day only while the compensation processes (decay of organic matter, etc.) are continuous and uniform, it follows that, due to plant consumption of carbon dioxide, the barometer will be lower at or about sundown than in the early morning by roughly 3×10^{-5} mm., a quantity quite too small for ordinary measurements.

15. *Changes in the atmosphere due to chemical actions.*

If we exclude the absorption of carbon dioxide by plants and their exhalation of oxygen, we have left the production of carbon dioxide as the result of animal life and of vegetable decay and combustion; the formation of ammonia from various sources; the production of different oxides of nitrogen; the formation of ozone, and a number of other chemical changes that have some effect on the quantity, both mass and volume, of the atmosphere. There is no evidence, how-

ever, that any of these or even all combined produce a measurable effect. At any rate none of them has a 12-hour period, nor, except in the case of the less important, even a 24-hour period, and therefore all may be regarded as negligible so far as measured changes in the barometer are concerned.

16. *Changes in the atmosphere due to condensation and evaporation.*

The formation and evaporation of dew, amounting roughly to 0.25 mm. per day in damp regions, and evaporation from plants and from water surfaces all contribute to more or less regular daily changes in the height of the barometer. Under the best conditions the evaporation of dew in the early forenoon can increase the barometer reading by only 0.02 mm., but even this small amount is by no means regular in its occurrence, and besides it does not occur over the oceans nor, ordinarily, on the desert regions of the land. Hence, obviously, it is not an important factor in the production of either the 12-hour or the 24-hour swing of the barometer.

Evaporation from plants is most rapid in the forenoon and may amount to as much as a layer 2 mm. thick and, hence, neglecting lateral flow, increase the reading of the local barometer by 0.15 mm., roughly. But plant evaporation, too, is irregular, and applies only to land surfaces and during growing seasons. Hence plant evaporation is also insufficient to account to any large extent for the daily changes of the barometer.

Evaporation from the ocean and other water surfaces is more or less continuous but irregular in magnitude since it depends upon temperature, wind velocity, and humidity of the atmosphere. On the whole it is greater by day than by night but the difference over the ocean probably is less than 0.5 mm., equivalent to a barometric change of about 0.04 mm., and therefore, even if regular, too small to produce the observed daily swings of the barometer.

17. *Tides in the atmosphere.*

Just as tides are produced in the ocean due to the gravitational action both of the sun and of the moon, so, too, similar gravitational tides must occur in the atmosphere, but they are very small. According to Lamb [1] the barometric amplitudes of the solar and lunar tides are about 0.012 mm. and 0.027 mm., respectively, or both together not more than the thirtieth part of the actual daily amplitude of the barometric swing. The moon is ruled out as the cause of the daily changes of the barometer also by the fact that the times of occurrence of maximum and minimum pressures have no relation to its phases or hours of rising and setting. On the other hand the agreement of the times of barometric maxima and minima with the movements of the sun suggests the idea that solar tides, through the free oscillation of the earth's atmosphere, might be the real cause of the semidiurnal

[1] Proc. Roy. Soc. A. 84, p. 556, 1910.

changes of the barometer. But this, too, is definitely ruled out[1] by the fact that the time of maximum pressure is before noon and not after, as it would be, owing to friction, if of tidal origin.

In reality the solar tide should increase the barometric pressure by 0.012 mm. shortly after noon and after midnight; and decrease it by the same amount near 6 o'clock morning and evening. Similar relations hold in regard to the movements of the moon and its tides; but as the hours at which these occur change from day to day they will not be further considered in connection with the regular diurnal and semidiurnal swings of the barometer.

18. *Gravitational distortion of earth and ocean.*

It has been known for a long time that there is a tidal rise and fall at sea as well as along the shore, and it is now known that tides apply also to land areas—that twice a day, nearly, the surfaces of continents within the Tropics rise and fall through an average range of roughly 34 centimeters, and to a less extent at higher latitudes. This land swell or ebb keeps close under the moon since earth waves travel faster than the rotational velocity of any point on the earth's surface, and therefore generally is not in phase with either the diurnal or the semidiurnal changes of the barometer. The tendency of the swell in question is to cause the atmosphere to flow to the corresponding and simultaneous sink, but even if this flow was perfect, which it is not, it would cause a barometric amplitude or change above and below the average of only about 0.016 mm. Besides, even this small change is essentially in opposition to the tidal effect in the atmosphere, the one increasing pressure when and where the other is decreasing it.

The tidal rise and fall of the ocean surface necessarily produces the same sort of barometric changes as do the land tides, but roughly twice as large. However, the tendency is for the two tides, land and water, to be in quarter phase with each other, so that the positive effect of the one generally coincides, roughly, with the negative effect of the other, so that 0.016 mm. is about the upper limit to the theoretical barometric change due to tidal action on land and water. Presumably it is actually much smaller, and at any rate mainly of lunar period and therefore can have no appreciable influence in producing the regular semidiurnal changes of the barometer.

CHIEF CAUSES OF THE SEMIDIURNAL CHANGES OF THE BAROMETER.

The above 18 separate causes of daily changes in atmospheric pressure have such different phases that while some are increasing the height of the barometer others at the same time are decreasing it, but except the first, or flow of air from warmer toward colder regions (discussed above only in its relation to the diurnal change) they

[1] Lamb, loc. cit.

individually are of such small effect that even if they operated simultaneously and in the same sense (they do neither) the combined result would not be the tenth part of the semidiurnal change of the barometer actually observed.

The real cause then of the semidiurnal barometric swing must be some phenomenon or combination of phenomena other than those already discussed, and the following are suggested as important contributing causes of the barometric changes in question.

19. *Horizontal flow of the atmosphere from the regions where it is most expanded toward those where it is most contracted.*

This is the same as cause 1, but it will be used here in partial explanation of the 12-hour swing of the barometer instead of the 24-hour swing as above.

The exact hour at which the atmosphere is warmest and therefore most expanded depends upon a variety of circumstances, but on the average it is approximately at 4 o'clock in the afternoon. Hence in general at about this time the amount of air overhead, counting from sea level, should be least, and therefore at this hour a sea-level barometer should have its lowest reading. Further, it would appear from the average daily change of temperature and from the value of atmospheric viscosity, as already explained in the discussion of the 24-hour change, that the atmospheric overflow resulting from the cause in question may fully account for the afternoon or 4 o'clock barometric minimum.

20. *Unsymmetrical overflow of the atmosphere from the warmest toward the coldest regions.*

Consider the condition of the atmosphere around the earth, and for simplicity let it be at the time of equinox. Under these conditions the atmosphere as a whole is coldest and most condensed just before 6 o'clock in the morning, or just before the beginning of morning insolation, and most expanded at about 4 o'clock in the afternoon. Hence, the time interval from morning maximum condensation till the following afternoon maximum expansion is about 10 hours, while the interval from afternoon maximum expansion till the next morning maximum condensation is approximately 14 hours, and therefore the actual distance along any parallel east from the meridian of maximum expansion to the meridian of maximum condensation is to the corresponding distance west, roughly as 5 to 7. In other words, the average pressure gradient in the upper atmosphere, starting at the meridian of maximum expansion and stopping at the meridian of minimum temperature, is greatest toward the east and least toward the west Moreover, the distance between the quiet and flowing layers is also greatest to the east, and therefore the frictional resistance least in this direction. Hence, considering both pressure gradient and friction, it appears that the overflow of the upper air may be about twice as great

eastward as westward; that is to say, so far as the overflow alone is concerned the average movement of the upper atmosphere is from west to east; but it reverses its direction, at any given place, at intervals of 10 and 14 hours, and besides during the day is not of constant velocity in either direction, though during the night the flow from east to west can vary but little, there being no insolation and the cooling being continuous and nearly uniform.

There must be, then, on the average, a rise of the barometer (along a parallel of latitude) westward from the meridian of maximum expansion toward the meridian of maximum condensation, and another but more rapid rise, because of the greater overflow in that direction, eastward from the meridian of greatest heat toward the meridian of greatest cold. Hence, it would appear that mere gravitational overflow and underflow (the former is most effective), resulting from thermal expansion and contraction, must cause a minimum barometer about 4 o'clock in the afternoon and a maximum about 6 o'clock in the forenoon, together with higher readings during the short than during the long interval, or higher during the 10-hour than during the 14-hour interval.

The 24-hour swing of the barometer, therefore, does not appear to be of even period, but rather of intervals that are to each other roughly as 5 to 7. To be sure the barometer is lower at 6 o'clock in the afternoon than it is at the same hour of the morning, and hence one may assume an even period 24-hour swing with a morning 6 o'clock maximum and evening 6 o'clock minimum, and partially correct this regular curve (the correction is never perfect) by the superposition of one or more additional sine curves of convenient periods. But this approximation to the true curve does not prove the actual components to be exactly as assumed.

It appears, then, that the physical causes back of the 24-hour change are such as to give a morning maximum pressure at about 6 and an afternoon minimum about 4 o'clock, with a barometer generally higher during the 10-hour than during the 14-hour interval. It does not account however for either of the 10 o'clock maxima.

21. *Interference by vertical convection with free horizontal flow.*

It is well known that the velocity with which water in the middle of a river moves downstream is a maximum at roughly one-third the depth, and that from this point it decreases to one value at the surface and to another, zero, value at the bottom. Friction holds the film of water in contact with the bottom at rest while viscosity checks the flow near the bed. But viscosity is not the only retarding influence, for if it were so the maximum velocity would be at the surface instead of at or about one-third the way down.

The additional disturbance to the free movement of the water is caused essentially by eddies that, being generated in the lower slow-

moving water, pass through the upper layers and thereby interfere with the flow. But the interference at a given level, due to a particular rising mass, obviously is operative only while the latter is passing through the level in question, and therefore the more rapidly an eddying mass rises the less its retarding effect on the lower layers and the greater its influence near the surface, where, since it can not rise higher, it must spread out and exert the whole of its remaining inertia, due to difference of velocity, on the flow of the stream.

If two layers of a stream, a fast moving one and a slow one, should mingle, the resulting changes in their rates of flow, the increase of the one and the decrease of the other, would be such that the total momentum, and therefore the total flow and the depth of the water, would all remain constant. But while mingling of this nature does take place, as above explained, it is not all that happens. Each mass that rises is replaced by another that descends, so that the more pronounced the turbulence the more effective the ground friction, and this obviously does decrease the flow and correspondingly increases the depth of the stream and the hydrostatic pressure at its bottom.

Now exactly this same sort of interference to free flow, this auto-obstruction or self-damming up of a stream through its own turbulence, applies equally well to the movements of the atmosphere. Here, too, the flow is slowest at the bottom and in general increases with elevation; and while there is no top surface, in the same sense that applies to the river, its equivalent is found at the limit of vertical convection at that particular time and place. Here, too, a rising mass is simultaneously replaced by an equivalent descending one, which in turn is either brought to rest or at least greatly checked in its flow by surface or ground friction.

We will consider this point a little closer: Let the mass m be near the ground and have the horizontal velocity v, and let the larger mass M be at a higher elevation and have, in the same direction, the greater velocity V. If now these two masses should mingle in such manner as to be free from all disturbance, except their own mutual interference, the resulting final velocity, U, in the same direction, would be given by the equation—

$$U=\frac{mv+MV}{m+M}$$

and there obviously would be no check in the total flow—no damming up and consequent increase of pressure. But, as already explained, this simple mixing of the two masses is by no means the whole story. The rise of the mass m is simultaneously accompanied by the descent of an equal amount from the larger mass M. Thus from a single interchange, due to vertical convection, the total momentum becomes—

$$2\,mv+(M-m)\,V$$

Hence, the total flow is reduced through ground friction by the amount

$$m(V-v)$$

But as this is for a single interchange, it is obvious that, the more active vertical convection becomes the greater will be its interference with the flow of the atmosphere, the more the winds be dammed up, and the higher the resulting barometric pressure.

In the case of rivers, the turbulence is due to eddies caused by ground friction, but in the atmosphere vertical convection, produced by differences in temperature, is of much greater importance than mere friction eddies. Consequently the surface winds are stronger and the upper winds weaker by day, when intermingled through vertical convection, than they are at night when no such mixing takes place. But this change in the velocity of the winds also implies, as above explained, that there has been a greater or less interference with the free flow of the atmosphere and an increase of its pressure at the surface of the earth. Further, vertical convection and the interference to the flow of the atmosphere it produces must vary together, so that, in general, as convection increases, reaches a maximum, and then decreases, so too will the resulting interference go through the same changes.

Now the general movement of the atmosphere is from east to west within the Tropics and from west to east at higher latitudes. Therefore in either case such damming up of the atmosphere as vertical convection may produce will be essentially along meridians, just as any given phase of vertical convection itself, which has to be substantially at right angles to the march of the sun, is also essentially along a meridian. In other words, convection and its attendant phenomena are functions of the time of day. But, in general, convection increases most rapidly during the forenoon, say, 8 to 9 o'clock, is most active at 10 to 11 o'clock, and reaches its greatest elevation about 4 o'clock in the afternoon. Hence the damming up of the atmosphere, due to vertical convection, and the resulting increase of barometric pressure must increase most rapidly during the forenoon, and come to a maximum about 10 o'clock. After this the convectional interference decreases, while at the same time the amount of atmosphere in a vertical column of fixed cross section decreases as a result of expansion and overflow, till at about 4 o'clock in the afternoon the barometric pressure, as we have already seen, has reached a minimum.

To form some idea of the magnitude of the barometric change due to convectional turbulence, consider the atmosphere between two parallels of latitude near the Equator. This limited quantity of the atmosphere may be regarded as a stream flowing around the earth,

having its minimum velocity and maximum depth where convection is greatest, and maximum velocity with minimum depth where convection is absent.

Now the linear velocity of a point on the Equator is approximately 28 kilometers per minute, while during the forenoon the rate of increase of the barometric pressure at the same place is roughly 0.2 mm. per hour. Hence a damming up, or check in the flow, of the given stream of atmosphere at the rate of 0.44 kilometer per hour would be sufficient of itself to account for the observed rise in the barometer. But if the average velocity of the wind, or flow of the stream in question, is 10 meters per second, which it may well be, the required change in the velocity could be produced by having, during the course of an hour, only 1 part in 80 of the whole superincumbent atmosphere in touch with the earth, an amount which, from the size of cumulus clouds, seems altogether reasonable. Besides, the necessary velocity change is of the same order of magnitude as that observed to take place during, and as the result of, vertical convection.

We may therefore regard convectional interference to the flow of the atmosphere as an important, if not the chief, cause of the forenoon barometric maximum.

I am glad to find, since developing the above idea, that Abbe [1] long ago urged convectional interference as the principal contributing cause of the forenoon maximum.

SUMMARY.

Summing up the effects of all the above causes of barometric changes, we find:

(*a*) That the afternoon minimum is due essentially to overflow from the region where the atmosphere is warmest, or better, perhaps, from the meridian along which the temperature increase has been greatest, toward that meridian along which there has been the greatest decrease in temperature.

(*b*) That this overflow, presumably, is mainly toward the east, because of the steeper pressure gradient in that direction, and that therefore the average barometric pressure, assuming this influence alone to be operative, should be higher to the east than to the west of the afternoon minimum.

(*c*) That vertical convection interferes with the free horizontal flow of the atmosphere and to that extent dams it up and correspondingly increases the barometric pressure. Also that the time of this interference agrees with the forenoon changes of the barometer, and that its magnitude, at least in conjunction with the unsymmetrical

[1] Preparatory Studies, pp. 8 and 56, 1890.

overflow, is of about the proper order to account for the forenoon barometric maximum.

The afternoon barometric minimum and the forenoon maximum, therefore, are to be regarded each as an effect of temperature increase; the mimimum as due to expansion and consequent overflow; the maximum as mainly caused by vertical convection and consequent interference with the free circulation of the atmosphere.

The forced afternoon minimum would occur in an otherwise stagnant atmosphere, and substantially as at present; but not so with the forced forenoon maximum since, so far as the interference or damming effect is concerned, it depends upon a flow or circulation of the atmosphere, parallel roughly to the Equator.

It remains now to account for the night 10 o'clock maximum and 4 o'clock minimum.

22. *Natural or free vibration of the atmosphere as a whole.*

This subject has been discussed by several mathematical physicists of great eminence. The latest and most complete of these discussions, and the one to which those interested in this phase of the barometric problem are especially referred, is by Lamb,[1] who concludes:

> Without pressing too far conclusions based on the hypothesis of an atmosphere uniform over the earth, and approximately in convective equilibrium, we may, I think, at least assert the existence of a free oscillation of the earth's atmosphere, of "semidiurnal" type, with a period not very different from, but probably somewhat less than, 12 mean solar hours.

Hence any cause of pressure change, having a semidiurnal period or approximately so, would, if of sufficient magnitude and proper phase, account for the 12-hour barometric curve. Such a cause, many think, may be found in the irregular daily march of temperature, since the curve expressing this march is more or less approximately resolvable into a diurnal and a semidiurnal sine curve. But the resolution is not perfect and besides there is no obvious cause for a temperature increase by night, and hence the reality of the semidiurnal component in the temperature curve is equally doubtful.

All that is needed, apparently, to give the semidiurnal pressure curve is a pressure impulse of the same period, 12 hours, as that of the free vibration of the atmosphere as a whole. And this, it seems, is furnished by the forced forenoon barometric maximum, followed 6 hours later at the same place by the forced afternoon barometric minimum. In other words, taken together the forenoon and afternoon forced disturbances appear to occur with the proper time interval necessary to set up and maintain the 12-hour free vibrations of the atmosphere.

The course of events at each locality, therefore, appears to be substantially as follows:

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[1] Proc. Roy. Soc. A. 84, p. 551, 1911.

1. A forced forenoon compression of the atmosphere followed by its equally forced afternoon expansion, the two together forming one complete barometric wave, with a 10 o'clock maximum and a 4 o'clock minimum, in harmony with the free vibration of the entire atmospheric shell.

2. Nondisurbance through the night or during the time of a single free vibration.

3. Repetition the following day of the forced disturbances in synchronism with, and therefore at such time as to reenforce, the free vibrations.

The series of disturbances, of course, is indefinitely great, forced by day and free by night, but the resulting amplitudes of the barometric changes are limited, through friction and through the absence of perfect synchronism, to comparatively small values.

Each point upon the atmospheric shell receives at every alternate swing a forced impulse in phase with the free vibration, and therefore at such time and in such manner as indefinitely to maintain the vibrations of the atmosphere as a whole. In other words, the forced vibrations are in harmony with and thereby sustain the free vibrations; both being continuously operative and daily following each other in an eternal chase around the world.

That the day extremes of pressure should be forced and the night extremes due to the free vibration of the atmosphere is in keeping with the fact that the former are greatest over continents where convection is greatest and least over oceans, while the latter are greatest over oceans and least over continents where frictional damping necessarily is most pronounced.

CONCLUSION.

Atmospheric pressure, as indicated by the barometer at sea level, passes through two conspicuous maxima and two equally conspicuous minima during the course of 24 hours, as follows:

(*a*) A forenoon 10 o'clock forced maximum, due essentially to convectional interference with and the resulting damming up of east-west winds.

(*b*) An afternoon 4 o'clock forced minimum, due to atmospheric overflow resulting from thermal expansion.

(*c*) An evening 10 o'clock maximum, caused by the 12-hour free vibration of the atmosphere in joint response to both the forenoon maximum and the afternoon minimum.

(*d*) A morning 4 o'clock minimum, caused also by the 12-hour free vibration of the atmosphere in response to the combined influence of both the forced disturbances.

The forenoon maximum and the afternoon minimum are primary disturbances equally forced but in different ways by the daily

increase of atmospheric temperature, while the evening maximum and the morning minimum are secondary disturbances caused each by the joint action of the forced primaries through the 12-hour free vibration of the atmosphere. In short the semidiurnal swing of the barometer is a result of merely fortuitous circumstances—of the fact that the mass of the atmosphere happens to be such that the period of its free vibration is approximately just one-half that of the earth's rotation.

The secondary disturbances react, of course, upon and increase the primaries, and so on through a more or less lengthy series, but friction and want of perfect coincidence prevent them from ever becoming excessively large.

In addition to the above four daily barometric extremes, two maxima and two minima, there appear to be, according to harmonic analysis, at least two others, a 6 o'clock morning maximum and a 6 o'clock evening minimum.

In reality there is no absolute maximum at 6 o'clock in the morning nor absolute minimum in the evening; but, owing to atmospheric flow, the sea-level pressure averages higher during the cooler than it does during the warmer hours. The division, however, presumably is not symmetrical, though for simplicity assumed so in the analysis, for the maximum tends to occur during the coldest hour, or about dawn, while the minimum tends equally to occur near mid-afternoon, when the atmosphere as a whole is most expanded.

BIBLIOGRAPHY.

It would be difficult, and probably of but little use, to obtain a complete list of the numerous papers that discuss the daily variation of the barometer. But there are some that are of fundamental importance, either because of the wealth of observational material they furnish or because of the appropriate equations they discuss. Among them are:

ANGOT. *Etude sur la marche diurne du baromètre.* (Annales du Bureau Central Mét. 1887.)

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LAMB. Proc. Roy. Soc. A. 84, p. 551, 1911.

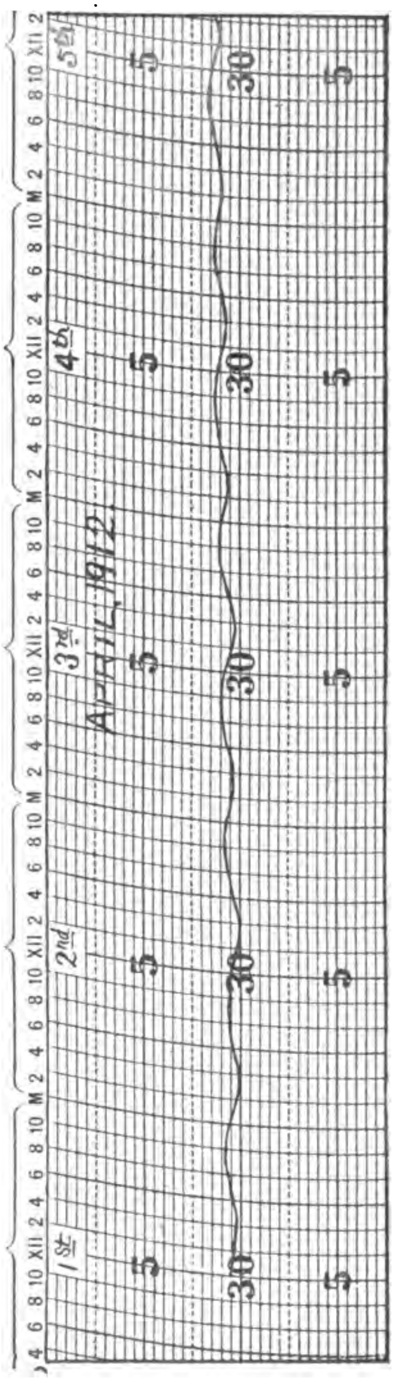

Fig. 1. Barogram. Grand Turk Island, West Indies. Seventy-fifth meridian time.

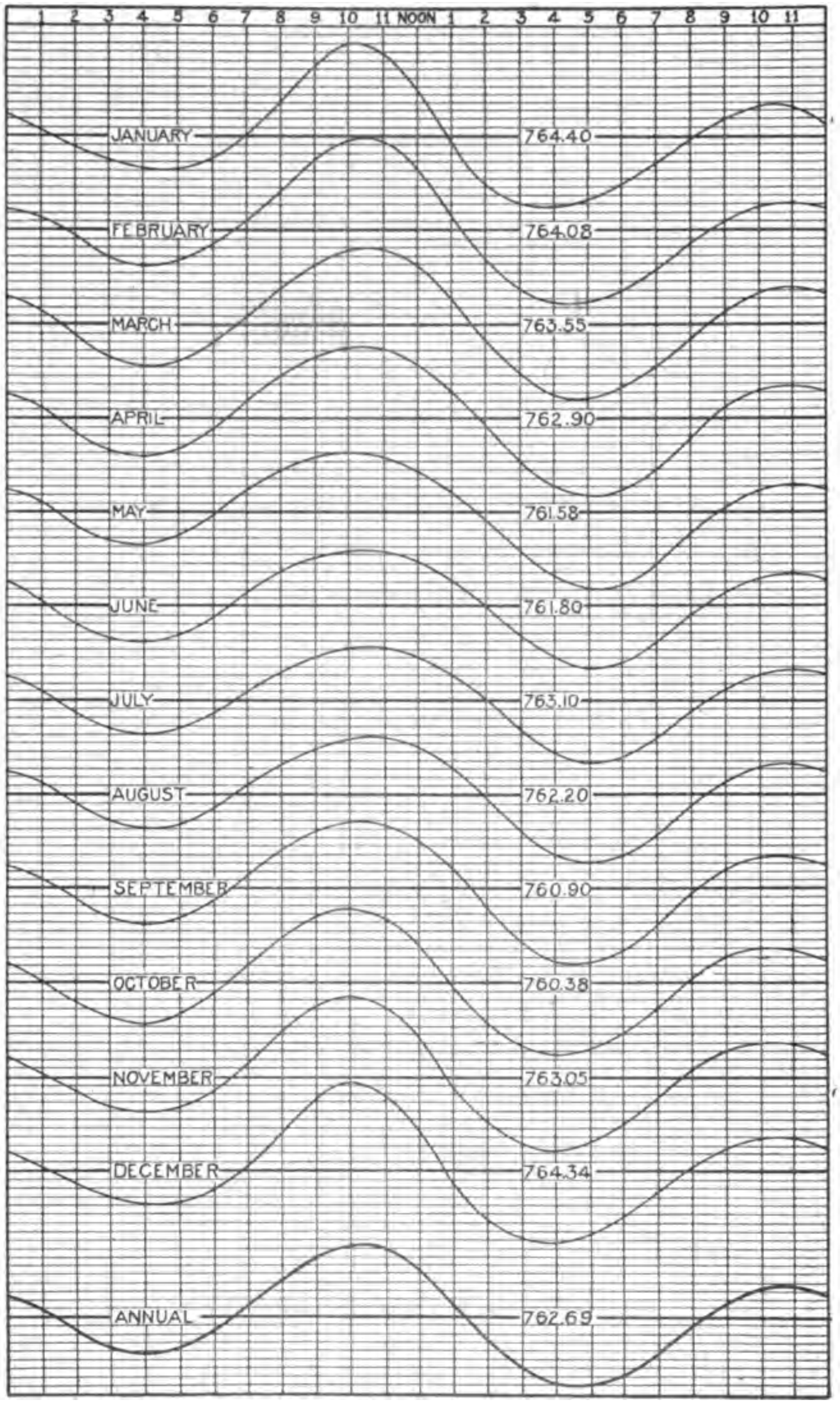

FIG. 2.—Average daily barometric curves. Key West, Fla. Seventy-fifth meridian time.

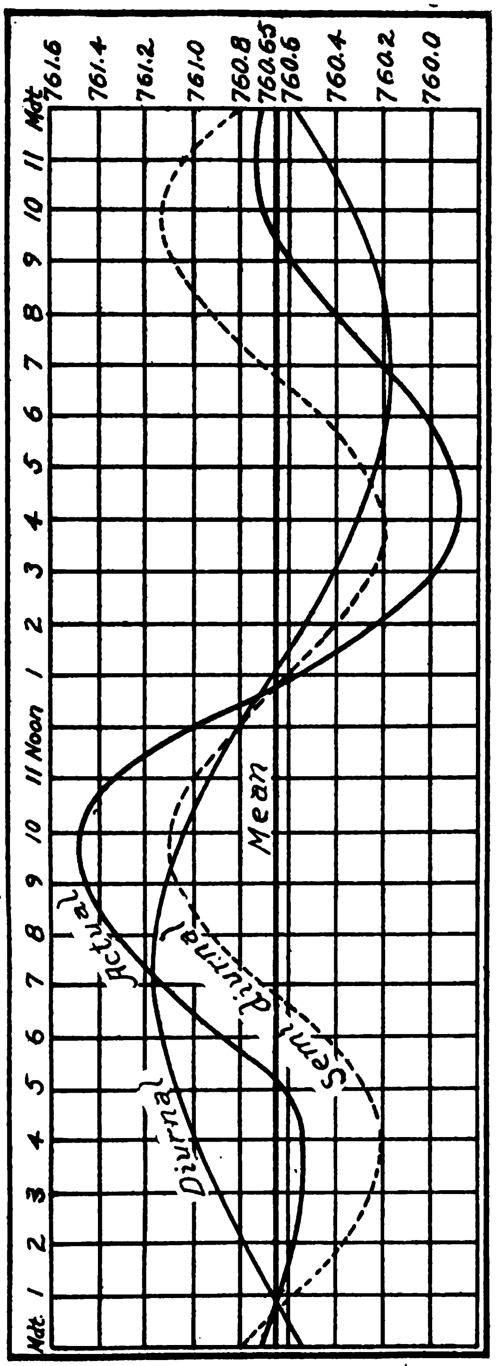

FIG. 3.—Average daily barometric curve and its components. Washington, D. C. (After W. J. Bennett.) Seventy-fifth meridian time.

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(V) THE DENSE HAZE OF JUNE 10–11, 1912.

By HERBERT H. KIMBALL.

[Dated July 18.]

From June 8 to 12, 1912, the atmospheric conditions at Mount Weather were dominated by an area of high pressure that slowly advanced during the five days from the Upper Mississippi Valley to the South Atlantic coast, and was nearly central over Mount Weather on the 10th and 11th.

There was a decided fall in temperature on the 7th and 8th which the kite observations show extended to a height of at least 3 kilometers. Naturally the low temperature of the 8th was accompanied by a low vapor content of the atmosphere.

The kite observations of the 9th show that the temperature of the air up to a height of at least 3 kilometers was rising. There was not sufficient surface wind for kite flights on the 10th and 11th, but the flights on the 12th showed that there had been a general warming of the atmosphere to a height of at least 4 kilometers and an increase in the absolute humidity. (See p. 206–7 for kite observations.)

The data in Table 1 help to make clear the changes in atmospheric transparency that occurred during the above period.

TABLE 1.—*Solar radiation and sky polarization data for Mount Weather, Va., on the mornings of June 8 to 12, 1912.*

Date.	*H. A.*	*h.*	*m.*	*P.*	*Q.*	*Q'.*	*a.*	*H.*	*C.*
1912.	h. m.	°							
June 8.....	−5 47	16.5	3.5	63	0.972	1.000	0.830	....	....
9.....	−5 48	16.5	3.5	60	0.964	0.994	0.828	....	....
10.....	−5 48	16.5	3.5	35	0.641	0.661	0.737	....	....
11.....	−5 48	16.5	3.5	31	0.336	0.347	0.613	....	....
12.....	−5 49	16.5	3.5	53	0.773	0.797	0.778	....	....
June 8.....	−5 10	23.5	2.5	61	1.097	1.131	0.809	....	....
9.....	−5 11	23.5	2.5	59	1.184	1.221	0.834	....	....
10.....	−5 11	23.5	2.5	37	0.795	0.820	0.711	....	....
11.....	−5 11	23.5	2.5	27	0.505	0.521	0.593	....	....
12.....	−5 12	23.5	2.5	54	0.925	0.954	0.756	....	....
June 8.....	−3 36	41.8	1.5	59	1.291	1.331	0.783	0.861	0.952
9.....	−3 36	41.8	1.5	64	1.355	1.397	0.808	0.904	0.976
10.....	−3 36	41.8	1.5	23	0.861	0.888	0.598	0.574	0.765
11.....	−3 37	41.8	1.5	22	0.769	0.793	0.554	....	....
12.....	−3 37	41.8	1.5	52	1.187	1.224	0.740	....	....
June 8.....	−0 50	70.7	1.05	....	1.374	1.416	0.748	1.297	1.496
9.....	−0 48	70.9	1.05	....	1.390	1.433	0.756	1.314	1.450
10.....	−0 55	70.2	1.06	14	1.057	1.091	0.586	0.995	1.289
11.....	−0 47	71.2	1.05	15	0.959	0.989	0.531	....	....
12.....	−2 36	53.4	1.25	....	1.269	1.309	0.736	....	....

NOTE: *H. A*=Hour angle of sun from the meridian of Mount Weather.
h=Altitude of sun above the horizon in degrees.
m=Air mass=secant of sun's zenith distance (approximately).
P=Percentage of polarization of skylight at point of maximum polarization.
Q=Intensity of solar radiation (gram-calories per minute per cm^2 of normal surface).
Q'=Intensity of solar radiation reduced to mean solar distance.
a=Atmospheric transmissibility $\left(a^m=\frac{Q'}{1.922}\right)$.
H=Vertical component of solar radiation intensity (=$Q \sin h$).
C=Intensity of total radiation received upon a horizontal surface.

On the 8th and 9th the atmosphere was unusually clear for June, except that cirrus clouds were present at intervals and cumulus clouds formed on both days. There were no clouds on the 10th except a few cirrus after 5 p. m. The lower atmosphere was still clear, so that mountains 30 miles distant were distinctly visible, but the upper atmosphere was filled with a white veil of haze. Just before noon the polarization of skylight, P, which was 67 per cent at 9 a. m. of the 9th, had decreased to 14 per cent, and the atmospheric transmission coefficient, a, which was 0.756 shortly before noon of the 9th, had decreased to 0.586. During the afternoon the atmosphere cleared somewhat, the value of a at 5.10 p. m. with the sun 23.5° above the horizon being 0.751 and the value of P 42 per cent. At sunset P had increased to 64 per cent.

On the morning of the 11th the lower atmosphere was less clear than on the three preceding days, and the dense haze of the 10th still persisted in the upper atmosphere. In consequence the values

of a and P were generally lower than on the morning of the 10th. A cirrus cloud sheet prevented observations after noon.

On the morning of the 12th the haze had become light in the upper atmosphere, but was dense in the lower atmosphere, so that mountains 16 miles distant were completely obscured. A strong odor of smoke was noticeable, but no forest fires had been observed from Mount Weather. In spite of the dense surface haze, there was a marked increase in the values of both a and P. Clouds covered the sky before noon.

The antisolar and the solar distances of the neutral points of Arago and Babinet, respectively, were measured at about the time of sunset on the 8th and 10th, and the results are given in Table 2. The antisolar distance of Arago's point was slightly greater on the 10th than on the 8th, while the solar distance of Babinet's point was more than 2° greater.

TABLE 2.—*Antisolar distance and solar distance, respectively, of the neutral points of Arago and Babinet.*

Sun's altitude.	Arago's point.		Babinet's point.	
	June 8.	June 10.	June 8.	June 10.
°	°	°	°	°
+2.0	20.0	20.4	....	....
1.8	19.5	20.4	....	....
1.6	19.4	19.8	....	....
1.4	18.9	20.0	....	....
1.2	19.0	20.1	....	....
1.0	18.8	20.1	....	....
0.8	19.0	20.3	....	....
0.6	18.9	19.5	....	....
0.4	18.9	19.8	....	....
+0.2	19.3	20.0	....	....
±0.0	18.9	19.8	....	....
−0.2	19.1	19.3	....	....
0.4	18.6	19.2	....	....
0.6	....	19.1	....	19.5
0.8	....	18.8	16.7	19.2
1.0	....	18.3	16.6	19.0
1.2	....	18.6	16.8	18.6
1.4	....	18.4	17.0	18.7
1.6	....	18.7	17.0	18.8
1.8	....	18.5	....	19.1
2.0	....	18.4	....	19.0
2.2	17.3	18.3	....	18.9
2.4	18.2	18.2	16.8	19.2
2.6	....	17.9	....	19.1
2.8	....	18.1	....	19.2
3.0	....	18.3	16.4	18.9
3.2	....	18.7	16.6	18.6
3.4	....	18.7	15.8	18.2
3.6	....	....	15.4	18.0
3.8	....	....	15.5	....
−4.0	....	....	15.6	....

Comparisons in Table 1 between the vertical component of direct solar radiation, H, and the total radiation received upon a horizontal surface from both sun and sky, C, show that while on the 8th and 9th the radiation received diffusely from the sky was about 10 per cent of H, on the 10th it was 30 per cent.

To summarize, the most strongly marked optical phenomena of these five days were as follows:

1. A decided decrease in the atmospheric transmissibility, a, and in the sky polarization, P, from the morning of the 9th to the morning of the 10th.

2. An unusually large diurnal variation on the 10th in the values of both a and P, with the minimum values shortly before noon.

3. A decided increase in the solar distance of Babinet's neutral point on the 10th as compared with the 8th.

While increased haziness at the center or in the rear of an area of high pressure is a common occurrence, the haze of June 10 and 11 was of unusual density.

Since the winds throughout the entire period were generally from some point between north and west, and were light on the 10th and 11th, we must attribute the increased haziness of these two days to processes taking place in the atmosphere rather than to changes in the constituents of the atmosphere due to a shift in the wind direction.

The most effective process during the period appears to have been convection, which must have carried considerable quantities of dust and moisture from the surface to at least the top of the cumulus cloud layer, or about 3 kilometers above sea level.

On account of the light winds that prevailed, probably both dust and moisture accumulated in the atmosphere on the 10th and 11th, but were swept away by the higher winds of the 12th.

In addition, innumerable little whirls would be established in a body of stagnant air that was being heated rapidly and unequally from point to point, on account of variations in the character of the radiating surface below. At the boundary surfaces of these whirls heat and light waves would be both reflected and refracted, thereby adding to the haziness attributable directly to dust particles. These whirls would be most numerous at the time of the most rapid rise in temperature, or from shortly after sunrise to shortly before noon, and would cease before sunset.

The air would also be relatively drier in the afternoon than in the morning, on account of its increased temperature, and in consequence the dust particles would have less hazing effect.

It appears, therefore, that the dense haze of June 10 to 11, 1912, may be attributed to the effects of convection in quiescent air prevailing at the center of a nearly stationary area of high pressure, and that the unusual daily variation in atmospheric transparency was the result of diurnal heating and cooling.

A rapid diminution in the solar distance of Babinet's point occurred on both the 8th and 10th when the sun was about 3° below the horizon, but the change was especially well marked on the 10th. It

therefore seems probable that the upper limit of the haze on the 10th was approximately 3 kilometers above sea level, or at about the top of the cumulus cloud layer of the two preceding days, a conclusion that is based on recent studies by Süring and Humphreys.[1]

Additional note.—The unusually hazy condition that was first observed on the morning of June 10, 1912, has continued, although with varying intensity from day to day, up to the date, August 31, 1912, when the proof sheets of this paper are being revised. This is shown by a comparison of data for the years 1911 and 1912, as tabulated in Table 3.

TABLE 3.—*Comparison of polarization and radiation data for the months of May to August, inclusive, 1911 and 1912.*

Period.	Percentage of polarization of sky light.				Maximum radiation intensities.					
	1911		1912		1911			1912		
					Air mass.			Air mass.		
	Max.	Min.	Max.	Min.	1.0	1.5	2.0	1.0	1.5	2.0
May	66	36	72	34	1.32	1.19	1.06	1.42	1.27	1.19
June 1-9			67	54	1.36	1.22	1.12	1.42	1.36	1.24
June 10-30	72	47	64	14	1.48	1.37	1.27	1.25	1.19	1.05
July	74	31	47	13	1.47	1.37	1.31	1.24	1.05	0.96
August	76	44	41	23	1.39	1.33	1.23	1.08	1.02	0.86

It is possible that dust from the volcanoes that were active in Alaska early in June has added its hazing effect to that due to the causes already considered.

[1] Humphreys, W. J., Dust layers in the atmosphere and changes in the neutral points of sky polarization. Bulletin of the Mount Weather Observatory, vol. 4, p. 397.

(VI) THE INFLUENCE OF CLOUDS ON THE DISTRIBUTION OF SOLAR RADIATION.

By HERBERT H. KIMBALL and ERIC R. MILLER.

[Dated Aug. 1, 1912.]

It is a matter of common observation, subconscious in most cases, that with favorable relative position of clouds and sun the solar rays seem concentrated.

The Callendar pyrheliometer, as ordinarily exposed, gives a continuous record of the vertical component of the intensity of radiation received from both the sun and the sky. Records obtained with this instrument at Mount Weather, Va., and Madison, Wis., afford several interesting examples of increased radiation intensity due to such concentration of the sun's rays. A few of these records are here reproduced, while reference is made to others. In comparing these records it should be borne in mind that the vertical, or intensity, scales for the Madison and the Mount Weather records are unequal.

At Madison, on February 5, 1912, at 10.40 a. m., a glaringly bright sheet of alto-stratus cloud advanced from the northwest. The recording pen of the register rose as the clouds approached the sun, attained a maximum of 1.11 gram-calories per centimeter per minute when the edge of the cloud reached the sun and then fell rapidly from this peak to a value somewhat lower than was recorded before the cloud came up. The record of February 3, 1912, a perfectly clear day, affords a good comparison curve, as apparently the atmospheric transmission was about the same on these two days, disregarding the effect of obscuration by the clouds. The value of the sun and sky radiation on the 3d at the time the peak was recorded on the 5th was 0.79 calories, so that the radiation of the 5th augmented by the cloud effect was 41 per cent higher than the radiation with the clear sky on the 3d. The cloud was a relatively thin sheet, and the temperature prevailing at the time, 12° F. at the surface, was low enough to insure its being made up of ice particles. Its brightness was therefore doubtless due in part to light received upon its upper surface and transmitted through the cloud by refraction and reflection.

The records for February 3 and 5 are reproduced in figure 1.

On July 28, 1912, a similar sheet of alto-cumulus cloud formed over the Blue Ridge at Mount Weather shortly after 8 a. m. It increased rapidly in extent, and by 8.41 a. m. had covered the sun. An imperfect solar corona was visible at times.

In figure 2 the red curve marked A is a copy of the record made by a horizontally exposed Callendar pyrheliometer on the morning of the above date. It is seen that as the edge of the cloud sheet approached the sun the concentration of the solar rays caused an increase in the recorded radiation of 13 per cent over what would have been recorded had the clear sky and its curve continued.

The black curve marked B is a copy of the record made by a Callendar pyrheliometer mounted in a diaphragmed tube, the angular opening from the center of the pyrheliometric surface to each side of the farthest square diaphragm being about 4°. The decrease in radiation intensity when the cloud sheet covered the sun was 30 per cent.

After a short interval of clear sky at 9 a. m., clouds again obscured the sun. At this time they were on all sides of it, and just before the sun was obscured the curve A shows an increase in radiation intensity of 20 per cent over what would have been received from a clear sky, as indicated by the broken curve.

On May 17, 1912, a strato-cumulus cloud sheet formed over the Shenandoah Valley to the west of Mount Weather, and at 9.15 a. m. advanced rapidly over the mountain. In the five minutes preceding the time at which the sun was obscured the recorded radiation intensity on a horizontal surface increased 12 per cent above the very regular curve that had been made with the clear sky previously prevailing.

At Mount Weather, on June 9, 1912, cumulus clouds formed very rapidly after 11 a. m., and between 11.03 a. m. and 11.19 a. m. the recorded radiation increased 11 per cent. On July 8, at 10 a. m., a thin fracto-cumulus cloud that formed between the zenith and the sun increased the radiation by 8 per cent, while on July 11, at 8.40 a. m., an alto-cumulus cloud sheet advancing from the west increased the radiation by 14 per cent.

In all these cases the zenith distance of the cloud was less than the zenith distance of the sun, and the clear sky that preceded the clouds made possible rather definite measurements of the increase in radiation intensity due to the clouds. When the clouds are in rather dense masses, as was the case at Mount Weather when cumulus clouds were present, the concentration of the solar rays must be attributed to reflection from the cloud surfaces.

There are also many cases in which the cloud effects, while marked, can not be accurately measured. A good example is the record obtained at Madison on June 3, 1912. The sky was clear until 9.30 a. m., when small cumulus clouds advanced from the northwest and covered the sky by 10.20 a. m. The alternate sunshine and shadow caused the recording pen to traverse the sheet rapidly, for the most part below the normal for that time of the day with a clear sky;

but at 11.30 a. m. the relative distribution of clear sky and cloud was such that an unusual concentration of radiation occurred. If we accept the record obtained on May 30, 1912, which was a clear day, as the clear-sky curve for June 3, then the excess of radiation due to reflection from clouds was the difference between 1.12 and 1.84 calories per minute per square centimeter of surface, or about 64 per cent.

There is some doubt about the proper value to be given the clear-sky radiation curve at 11.30 a. m. of June 3, since only a week later, on June 10, the general sky transparency had changed so much that the clear-sky value of the radiation at 11.30 a. m. was equal to the maximum of the peak obtained on June 3.

The curves for May 30, June 3, and June 10, 1912, are reproduced in figure 3.

Another good example of radiation intensities increased by reflection from clouds is the record for June 17, 1912, at Madison, when thin alto-cumulus or alto-stratus clouds prevailed throughout the day, causing the radiation intensity to fluctuate both above and below the clear-sky record of June 10, as is shown in figure 4.

The record for June 6, 1912, at Mount Weather, reproduced in figure 5, illustrates the effects of a thunderstorm cloud. Just before noon, at the height of the storm, the radiation was almost completely cut off, and it was so dark that artificial lighting was necessary in office and living rooms. At 12.48 p. m., after the passage of the storm, the radiation intensity was 13 per cent in excess of any radiation record obtained from a clear sky during the month. The excess was undoubtedly due to reflection from the great masses of cumulus clouds present in the atmosphere at the time.

To summarize, the records from Callendar recording pyrheliometers show that with favorable conditions of sun and clouds the vertical component of the intensity of radiation received from the sun and sky may be at least 40 per cent in excess of what would have been recorded had the sky been free from clouds, and that an excess of 10 per cent is quite common. In consequence, on partly cloudy days, such as June 17, 1912, at Madison, Wis., the cloudiness may diminish but slightly the total amount of radiation received at the surface of the earth. The concentration of the solar rays by clouds is principally due to reflection from their surfaces.

While some heat rays always penetrate through clouds, in the case of dense thunderstorm clouds the amount may be less than 1 per cent of the radiation intensity at noon when the sky is clear.

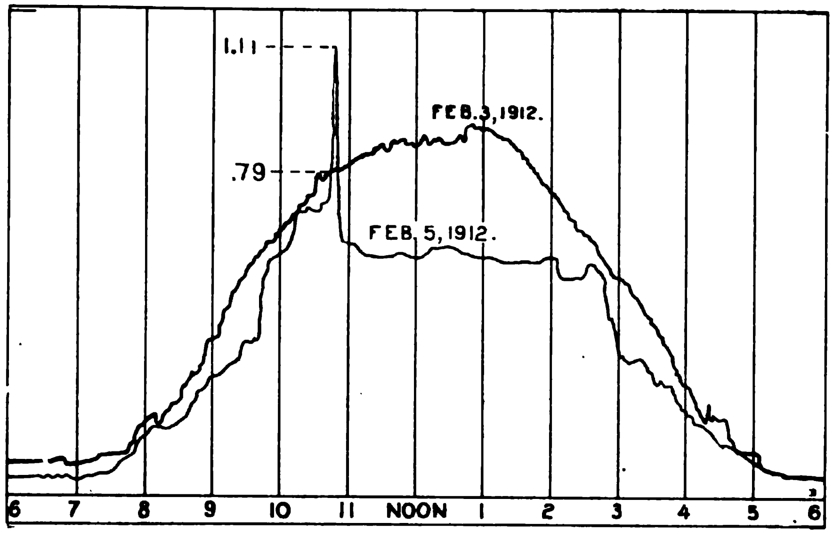

FIG. 1.—Records by Callendar pyrheliometer exposed horizontally. Madison, Wis., February 3 and 5, 1912.

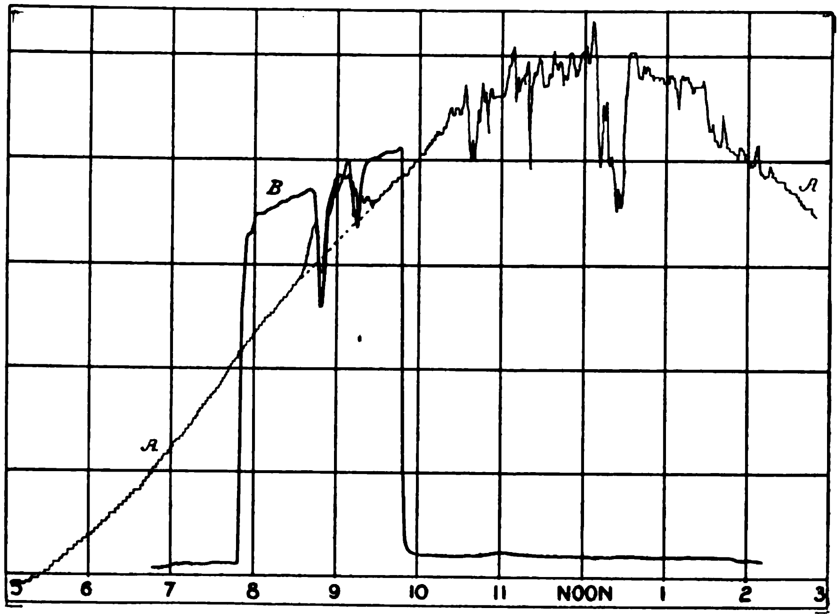

FIG. 2.—*A*, Record by Callendar pyrheliometer exposed horizontally; *B*, record by Callendar pyrheliometer in a diaphragmed tube showing intensity of solar radiation at normal incidence. Mount Weather, Va., July 28, 1912.

NOTE.—The vertical or intensity scales of *A* and *B* are unequal.

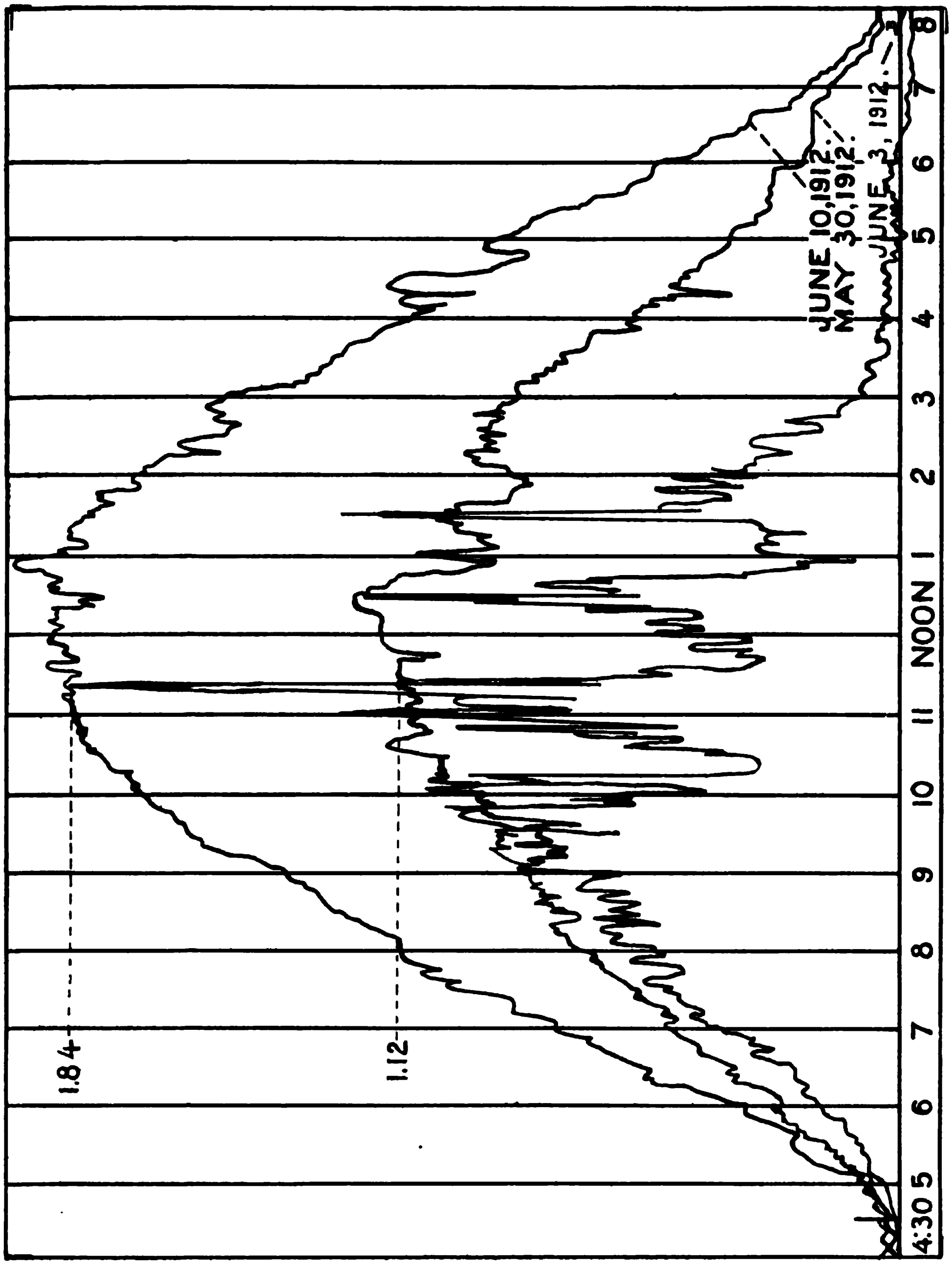

FIG. 3.—Records by Callendar pyrheliometer exposed horizontally. Madison, Wis., May 30, June 3, and June 10, 1912.

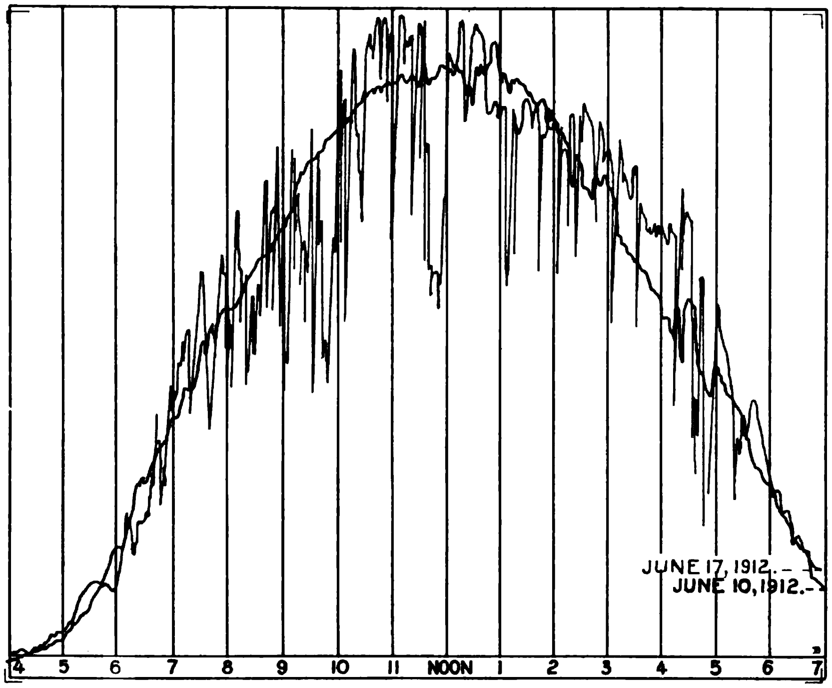

FIG. 4.—Records by Callendar pyrheliometer exposed horizontally. Madison Wis., June 10 and 17, 1912.

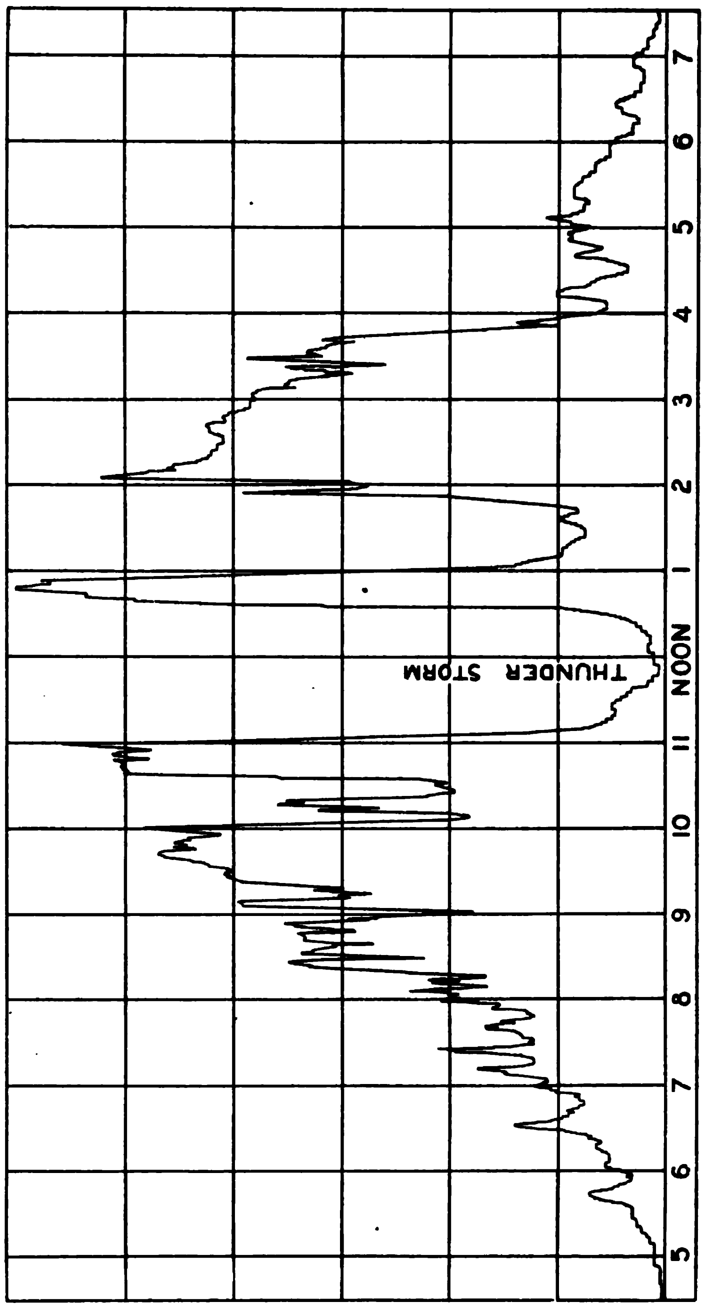

FIG. 5.—Record by Callendar pyrheliometer exposed horizontally. Mount Weather, Va., June 6, 1912.

(VII) SOLAR RADIATION INTENSITIES AT MADISON, WISCONSIN.

By HERBERT H. KIMBALL and ERIC R. MILLER.

[Dated Aug. 12, 1912.]

Since July 19, 1910, measurements of the intensity of the solar radiation received upon a surface normal to the direction of the solar rays have been made at Madison, Wis., on days when the sky was free from clouds.

INSTRUMENTS.

The Marvin pyrheliometer, standardized by comparison with a Smithsonian silver disk pyrheliometer, has been employed in making these observations. A brief description of this pyrheliometer will be found in the Bulletin of the Mount Weather Observatory, volume 3, part 2, page 81. Marvin pyrheliometer No. 1 was used from the beginning of observations until November 24, 1911, when it was replaced by Marvin pyrheliometer No. 5.

EXPOSURE OF INSTRUMENTS.

The observations have been made at the United States Weather Bureau office at Madison, which is located on the fourth floor of North Hall, University of Wisconsin. This hall is on the upper campus, and 500 feet south from the shore of Lake Mendota. The pyrheliometer has been exposed, during observations, on shelves outside the east and west windows of the office, at a height of 130 feet above the lake. The elevation above sea level is 974 feet and the latitude is 43° 05′ north.

The observations, which have only been attempted with clear skies, have occasionally been interrupted by clouds of smoke or condensed steam. The only considerable sources of smoke in the neighborhood are the central heating plant of the university, located 1,600 feet southwest of North Hall, and the switch yards of the Chicago, Milwaukee & St. Paul Railroad, about the same distance to the south. In summer with northwest winds the atmosphere is quite free from smoke, but in winter the low sun is liable to be obscured at times by smoke or rising clouds of condensed steam with the wind from any direction, except with northwest winds of considerable strength.

STANDARDIZATION OF INSTRUMENTS.

Seven sets of comparative readings between Marvin pyrheliometer No. 1 and Smithsonian silver disk pyrheliometer No. 1 were obtained between July 26, 1910, and August 9, 1910. These readings showed a progressive increase of about 3 per cent in the ratio of the indications of the Marvin to the Smithsonian instrument during this period. Four additional sets of comparative readings were obtained between these two instruments on November 24, 1911, and December 4, 1911, and they indicated a still further increase of about 3 per cent in the ratio of the Marvin to the Smithsonian instrument during the interval of 16 months since the preceding comparison.

The Marvin pyrheliometers are designed to enable independent determinations of their constants to be made by subjecting their resistance coils to the heating effect of a current of electricity of known strength, and measuring the resulting change in the resistance of the coils, their resistance at different temperatures having first been ascertained. In the case of Marvin pyrheliometer No. 1, it was found by tests made in the Instrument Division at Washington, after its return from Madison, that the heat capacity of its receiving disk had diminished with age. That is to say, an electric current of given strength produced a greater change in resistance in the coils after they had been in use for 18 months than was the case when the coils were first made up. The increase is expressed by the ratio $\frac{4.57}{4.294}$, which equals 1.064, and is practically the same as the increase in the ratio of Marvin No. 1 to Smithsonian No. 1 in the above period.

The receiving disk of Marvin pyrheliometer No. 5 was thoroughly seasoned before the instrument was standardized. Recomparisons made between March 28, 1912, and April 5, 1912, inclusive, did not disclose any change in its relation to the Smithsonian ilver-disk pyrheliometer. The latter instrument has been repeatedly compared with pyrheliometers at the Astrophysical Observatory of the Smithsonian Institution, and no change has been detected in its relation to the Smithsonian Standard in the two and one-half years it has been in the possession of the Weather Bureau.

The conclusion stated in the footnote in this Bulletin, volume 3, page 84 (that the close agreement between the indications of Marvin pyrheliometer No. 1 and the Smithsonian Standard led to the belief that Ångström pyrheliometer No. 104 gave measurements of radiation intensity that were too low by about 5 per cent), has been strengthened by the close agreement between Marvin pyrheliometer No. 5 and the Smithsonian Standard. The average of eight sets of simultaneous readings of Marvin No. 5 and Smithsonian No. 1 gave results by the former only 1 per cent lower than the indications of

the latter. This is a smaller difference than was to be expected, since in determining the constants of the Marvin instruments it has been assumed that the coefficient of absorption of the blackened surface of the coils is 1.0, while in fact it can hardly exceed 0.98.

REDUCTION OF OBSERVATIONS.

The measurements of the intensity of solar radiation have been plotted in the manner described in this Bulletin, volume 3, page 91, and the intensities corresponding to multiples of a half unit of air mass have been tabulated in Table 1.

The unit of air mass m is the zenith depth of the atmosphere. The values of m for different zenith distances have been obtained from a table of air masses published by Bemporad in Rend. Accad. Lincei, Anno 304, 1907. The zenith distance for each observation has been obtained from the recorded hour angle and the declination of the sun, by means of a special table constructed by interpolation in Ball's Altitude Tables. For further details with reference to the computation of the values of m the reader is referred to this Bulletin, volume 3, pages 93 and 94.

On account of the progressive change in the constants of Marvin pyrheliometer No. 1, a correction that increased with time has been applied to all the radiation intensity measurements made with this instrument between August 10, 1910, and November 15, 1911, inclusive. Although the values of this correction have been obtained by interpolation between the comparative readings with Smithsonian pyrheliometer No. 1 it is not believed that the corrected results for any month are in error from this cause by more than 1 per cent.

To facilitate comparisons with the five-year means for Washington, published in this bulletin, volume 3, pages 69–126, the monthly means of morning and afternoon observations at Madison have been collected in Table 2, at least three observations at any given air mass being considered necessary to give a mean value.

On account of the evidence, as set forth above, that Angström pyrheliometer No. 104 gives results that are too low by 5 per cent, the morning and afternoon monthly means of radiation intensity for Washington, given in this bulletin, volume 3, Table 2, pages 86–91, have been reduced to the Smithsonian standard by dividing by the factor 0.95, and are here reprinted in Table 3.

COMPARISON OF RESULTS OF OBSERVATIONS AT MADISON AND WASHINGTON, D. C.

While the differences in the averages of radiation intensities given in Tables 2 and 3 are unimportant for the warm months of the year, or from May to October, inclusive, the excess of the averages for Madi-

son over those for Washington for the cold months is pronounced. This is shown in Table 4 which gives the ratio of the Madison averages to the Washington averages.

A comparison of the atmospheric conditions at these two stations has been made by means of the atmospheric transmission coefficient, a, computed from the equation $a^m = \frac{Q'}{Q_0}$, where Q' is the value of the radiation intensity corresponding to m, reduced to mean solar distance, and Q_0 is the value of the solar constant, here assumed to be 1.922. The values of a for Washington and Madison for values of m between 1.5 and 2.5 inclusive, have been computed from the radiation intensities given in Tables 2 and 3, after these had been reduced to mean solar distance. The results are given in Table 5. As has been repeatedly pointed out, the value of a increases with the value of m for the reason that the locus of the equation

$$m \log a = \log Q' - \log Q_0$$

is slightly concave upward.

The excess of radiation intensities at Madison on clear days in winter as compared with the corresponding intensities at Washington can not be attributed to the difference in atmospheric pressure at the two stations, since their respective averages, about 29 inches of the barometer for Madison and 30 inches for Washington, would account for a difference of only 1 per cent in the values of a given in Table 5.

The excess can only partly be accounted for by the difference in vapor content of the atmosphere at the two stations. Abbot and Fowle [1] have found that on a clear day in winter in Washington the absorption of solar radiation by water vapor may amount to from 4 to 7 per cent of the value of the solar constant, or from 0.08 to 0.14 calories, when $m=2$. The average difference in the surface vapor pressures at the two stations does not exceed 2 millimeters, and would account for a difference in radiation intensities of only about 0.02 calories when $m=2$.[2]

These two causes combined therefore account for less than one-half the difference between the radiation intensities at Washington and Madison in winter. There remains to be considered the relative effect of the dust content of the atmosphere at the two stations, with respect to which no data are available. We are led to the conclusion, however, that on clear days in winter, when the northern part of the United States is generally covered with snow, the atmosphere at Madison contains much less dust than the atmosphere at Washington, a difference that does not prevail during the summer months.

[1] Annals of the Astrophysical Observatory of the Smithsonian Institution, Vol. II, p. 131.

[2] Kimball, Herbert H. Some causes of variation in the polarization of sky light. Journal of the Franklin Institute, April, 1911, p. 339.

Table 1.—*Madison, Wis.: Solar radiation intensities, expressed in gram-calories per minute per square centimeter of normal surface.*

Date.	Air mass.									
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
1910.										
July 19, a. m.	......	0.98	......	......	......	......	......	......	......	......
July 20, a. m.	......	1.10	......	......	......	......	......	......	......	......
July 25, a. m.	1.38	1.26	1.14	1.03	......	......	......	......	......	......
July 26, a. m.	1.30	1.16	1.04	0.93	......	......	......	......	......	......
July 27, a. m.	......	......	0.99	0.88	......	......	......	......	......	......
July 28, a. m.	1.24	1.13	1.03	0.94	......	......	......	......	......	......
July 29, a. m.	......	......	1.00	0.88	......	......	......	......	......	......
July 30, a. m.	1.27	1.12	......	0.91	......	......	......	......	......	......
July 31, a. m.	1.14	......	1.00	......	......	......	......	......	......	......
1911.										
July 3, a. m.	1.05	......	......	......	......	......	......	......	......	......
July 7, a. m.	1.05	1.02	0.95	......	......	......	......	......	......	......
July 11, a. m.	1.29	1.19	1.10	......	......	......	......	......	......	......
July 12, a. m.	1.36	1.29	1.17	......	......	......	......	......	......	......
July 14, a. m.	......	1.29	1.15	......	......	......	......	......	......	......
July 16, a. m.	......	1.26	1.20	......	......	......	......	......	......	......
July 17, a. m.	1.39	1.27	1.17	......	......	......	......	......	......	......
July 26, a. m.	1.32	1.26	......	......	......	......	......	......	......	......
Means	1.25	1.18	1.08	0.93	......	......	......	......	......	......
1910.										
July 26, p. m.	......	1.08	......	......	......	......	......	......	......	......
1911.										
July 12, p. m.	......	......	......	1.04	......	......	......	......	......	......
Means	......	[1.08]	......	[1.04]	......	......	......	......	......	......
1910.										
Aug. 5, a. m.	1.38	1.28	1.19	1.10	1.02	......	......	......	......	......
Aug. 6, a. m.	1.30	1.17	......	......	......	......	......	......	......	......
Aug. 9, a. m.	1.36	1.24	......	......	......	......	......	......	......	......
Aug. 10, a. m.	1.38	1.29	1.21	1.13	1.05	0.99	0.92	0.86	......	......
Aug. 11, a. m.	1.28	1.18	1.06	0.95	0.86	0.79	0.72	0.66	......	......
Aug. 19, a. m.	......	1.05	0.95	......	0.77	......	......	......	......	......
Aug. 26, a. m.	1.41	1.32	1.23	1.15	1.08	1.00	0.93	......	......	......
Aug. 27, a. m.	1.17	1.05	0.95	0.85	......	......	......	......	......	......
1911.										
Aug. 2, a. m.	......	1.24	1.21	......	......	......	......	......	......	......
Aug. 18, a. m.	......	1.25	1.14	1.09	......	......	......	......	......	......
Aug. 28, a. m.	......	1.29	1.21	1.13	......	......	......	......	......	......
Aug. 29, a. m.	......	1.28	1.20	1.13	......	......	......	......	......	......
Means	1.33	1.22	1.14	1.07	0.96	0.93	0.86	[0.76]	......	......
1910.										
Aug. 1, p. m.	......	......	0.83	0.69	0.59	......	......	......	......	......
Aug. 4, p. m.	1.40	1.28	1.16	1.05	0.96	0.62	......	......	......	......
Aug. 10, p. m.	......	1.21	......	......	......	......	......	......	......	......
Aug. 16, p. m.	......	1.03	0.83	0.71	0.62	0.55	......	......	......	......
Aug. 18, p. m.	......	1.09	0.98	......	......	......	0.66	0.58	0.51	......
Aug. 19, p. m.	1.23	1.09	0.99	......	......	......	......	......	......	......
Aug. 24, p. m.	......	0.82	......	......	......	......	......	......	......	......
Aug. 27, p. m.	......	1.00	0.84	......	......	......	......	......	......	......
1911.										
Aug. 18, p. m.	......	1.25	1.11	......	......	......	......	......	......	......
Aug. 29, p. m.	......	1.29	1.21	......	......	......	......	......	......	......
Means	[1.32]	1.12	0.99	0.82	0.72	[0.58]	[0.66]	[0.58]	[0.51]	......
1910.										
Sept. 2, a. m.	1.32	1.05	0.83	0.66	0.53	......	......	......	......	......
Sept. 6, a. m.	......	1.30	1.17	1.08	1.00	0.98	......	......	......	......
Sept. 7, a. m.	1.32	1.21	1.11	1.02	0.94	0.89	0.84	0.80	......	......
Sept. 9, a. m.	......	......	......	1.18	1.11	1.05	0.99	......	......	......
Sept. 10, a. m.	......	1.28	......	......	......	......	......	......	......	......
Sept. 14, a. m.	......	1.23	1.14	1.06	0.98	0.91	......	......	......	......
Sept. 15, a. m.	......	1.28	1.15	1.06	0.99	0.92	0.86	0.81	......	......
Sept. 16, a. m.	......	1.21	1.08	0.97	0.87	0.79	......	......	......	......
Sept. 20, a. m.	......	1.16	0.90	......	......	0.51	......	......	......	......
Sept. 21, a. m.	......	1.19	1.01	0.86	......	......	0.71	......	......	......
Sept. 22, a. m.	......	......	......	1.00	......	......	......	......	......	......
Sept. 28, a. m.	......	1.32	1.24	1.16	1.09	......	......	......	......	......
Sept. 29, a. m.	......	1.26	1.18	1.11	1.05	0.95	0.88	......	......	......

TABLE 1.—*Madison, Wis.: Solar radiation intensities, expressed in gram-calories per minute per square centimeter of normal surface*—Continued.

Date.	Air mass.									
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
1911.										
Sept. 16, a. m.		1.25	1.19	1.11	0.99					
Sept. 19, a. m.		1.30	1.22	1.14		1.00				
Means	[1.32]	1.23	1.10	1.03	0.96	0.89	0.86	[0.80]		
1910.										
Sept. 6, p. m.	1.41	1.29	1.18	1.08						
Sept. 7, p. m.		1.15								
Sept. 9, p. m.		1.27	1.18							
Sept. 10, p. m.		1.28	1.16	1.06						
Sept. 14, p. m.								0.87		
Sept. 15, p. m.		1.19	1.06	0.96	0.86	0.78	0.70	0.64	0.59	
Sept. 20, p. m.		1.22	0.74							
Sept. 21, p. m.		1.20	1.08	0.97	0.87	0.79	0.74	0.65	0.59	
Sept. 28, p. m.		1.29	1.20	1.12						
Sept. 29, p. m.		1.26	1.16	1.08	1.00	0.91	0.85	0.79		
1911.										
Sept. 16, p. m.					1.06					
Means	[1.41]	1.24	1.10	1.04	0.95	0.83	0.76	0.74	[0.59]	
1910.										
Oct. 1, a. m.		1.39	1.33	1.27	1.21	1.16	1.10			
Oct. 5, a. m.				0.92	0.82	0.75	0.71			
Oct. 6, a. m.			1.32	1.19	1.15	1.07	1.00			
Oct. 7, a. m.		1.31	1.21	1.11	1.02	0.94	0.87	0.80		
Oct. 8, a. m.		1.20	1.12	1.05	0.98	0.92				
Oct. 10, a. m.		1.32	1.21	1.12	1.03	0.94	0.87	0.80	0.73	
Oct. 11, a. m.		1.06	0.92	0.83	0.75	0.69				
Oct. 14, a. m.			0.87							
Oct. 16, a. m.						0.75	0.67	0.60		
Oct. 17, a. m.						0.77				
Oct. 18, a. m.		1.16	1.14							
Oct. 22, a. m.			1.28	1.21	1.11	1.02	0.93			
Oct. 23, a. m.		1.36	1.30	1.24	1.18	1.12	1.06			
Oct. 24, a. m.			1.20							
1911.										
Oct. 12, a. m.		1.28	1.17	1.08	1.01	0.94				
Oct. 28, a. m.		1.40								
Means		1.28	1.17	1.10	1.03	0.92	0.90	0.73	[0.73]	
1910.										
Oct. 1, p. m.			1.29	1.20	1.12					
Oct. 6, p. m.			1.19	1.11	1.03					
Oct. 7, p. m.			1.25	1.16	1.08	1.01				
Oct. 10, p. m.			1.30	1.19	1.09	1.04	0.98			
Oct. 11, p. m.			1.00					0.69	0.64	
Oct. 18, p. m.			1.12	0.98	0.87					0.50
1911.										
Oct. 12, p. m.			1.19	1.08						
Oct. 17, p. m.			1.23	1.23						
Oct. 28, p. m.			1.30	1.31	1.26					
Means			1.21	1.16	1.08	[1.02]	[0.98]	[0.69]	[0.64]	[0.50]
1910.										
Nov. 3, a. m.			1.36							
Nov. 5, a. m.			1.30	1.23				0.98		
Nov. 12, a. m.				1.33	1.27	1.22				
Nov. 25, a. m.				1.31		1.17	1.10			
1911.										
Nov. 2, a. m.			1.40	1.35	1.28	1.22	1.15	1.08	1.01	
Nov. 7, a. m.				1.25	1.18				0.91	0.86
Nov. 24, a. m.			1.40	1.35	1.28	1.22	1.16	1.10		
Nov. 29, a. m.					1.31	1.24	1.18			0.96
Means			1.36	1.30	1.26	1.21	1.15	1.05	[0.96]	[0.91]
1910.										
Nov. 3, p. m.				1.31	1.27					

TABLE 1.—*Madison, Wis.: Solar radiation intensities, expressed in gram-calories per minute per square centimeter of normal surface*—Continued.

Date.	Air mass.									
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
1911.										
Nov. 2, p. m.			1.35	1.33	1.30					
Nov. 15, p. m.				1.30	1.27					
Nov. 16, p. m.				1.24						
Nov. 24, p. m.				1.31	1.24					
Nov. 25, p. m.				1.35	1.27	1.19				
Means			[1.35]	1.31	1.27	[1.19]				
1910.										
Dec. 5, a. m.				1.34						
Dec. 6, a. m.				1.30	1.22					
Dec. 8, a. m.				1.38			1.06			
Dec. 12, a. m.				1.26	1.20				0.99	0.95
Dec. 14, a. m.				1.23	1.14	1.06				
Dec. 15, a. m.				1.37						
Dec. 27, a. m.					1.19	1.18		1.08		
Dec. 30, a. m.					1.26	1.25	1.17	1.10		
1911.										
Dec. 5, a. m.					1.16	1.11			0.93	0.89
Dec. 6, a. m.				1.23		1.08				0.84
Dec. 27, a. m.				1.37	1.29	1.22	1.15			0.97
Dec. 28, a. m.										1.03
Means				1.31	1.21	1.15	1.13	[1.09]	[0.96]	0.94
1910.										
Dec. 8, p. m.					1.29			0.97		
1911.										
Dec. 6, p. m.					1.11					
Dec. 27, p. m.					1.35	1.28				
Means					1.25	[1.28]		[0.97]		
1911.										
Jan. 3, a. m.							1.23			
Jan. 30, a. m.			1.53	1.46		1.34		1.15		
1912.										
Jan. 5, a. m.				1.50						1.07
Jan. 9, a. m.					1.40			1.17		
Jan. 10, a. m.				1.43	1.29					
Jan. 12, a. m.				1.51	1.43					
Jan. 27, a. m.			1.46	1.40	1.34		1.23	1.18		
Jan. 29, a. m.			1.42	1.32	1.22			0.97	0.90	
Jan. 30, a. m.			1.36							0.84
Means			1.44	1.44	1.34	[1.34]	[1.23]	1.12	[0.90]	[0.96]
1911.										
Jan. 3, p. m.								1.16		
1912.										
Jan. 5, p. m.				1.58	1.47	1.36				
Jan. 9, p. m.					1.43					
Jan. 12, p. m.				1.55	1.44		1.18			
Jan. 15, p. m.				1.44	1.39					
an. 19, p. m.				1.52	1.03					
Jan. 20, p. m.				1.22	1.21	1.14				
Jan. 23, p. m.				1.39	1.35	1.28	1.21			
Jan. 24, p. m.				1.42	1.38					
Jan. 29, p. m.				1.30	1.24	1.18				
Jan. 30, p. m.			1.40	1.39	1.33					
Means			[1.40]	1.42	1.33	1.24	[1.20]	[1.16]		
1911.										
Feb. 21, a. m.			1.45	1.37		1.24	1.18			
Feb. 22, a. m.			1.51	1.41	1.32	1.22	1.13			
Feb. 23, a. m.		1.61	1.51	1.45		1.28		1.18	1.12	
Feb. 24, a. m.		1.54	1.46					1.09		
Feb. 25, a. m.			1.40		1.23		1.12	1.06		
Feb. 27, a. m.		1.48	1.41	1.29	1.24	1.17		1.05		

TABLE 1.—*Madison, Wis.: Solar radiation intensities, expressed in gram-calories per minute per square centimeter of normal surface*—Continued.

Date.	Air mass.									
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
1912.										
Feb. 2, a. m.			1.54	1.49	1.41	1.34	1.28		1.17	1.12
Feb. 3, a. m.			1.57	1.49	1.37		1.21	1.13		
Feb. 7, a. m.			1.51	1.45		1.24	1.16			
Feb. 8, a. m.			1.56	1.49	1.41	1.33			1.15	1.08
Feb. 9, a. m.			1.52	1.44	1.37	1.27	1.18	1.09		
Feb. 22, a. m.		1.61	1.52	1.43	1.35	1.26	1.19	1.12		
Feb. 28, a. m.			1.41	1.35	1.28	1.21	1.15	1.07		
Feb. 29, a. m.								0.89		
Means		1.56	1.49	1.42	1.33	1.26	1.18	1.08	1.15	[1.10]
1911.										
Feb. 4, p. m.				1.35		1.25				
Feb. 22, p. m.		1.54	1.47	1.40					1.10	
Feb. 23, p. m.			1.53	1.45	1.32	1.27				
Feb. 24, p. m.			1.46			1.25				1.02
1912.										
Feb. 3, p. m.				1.52	1.45					
Feb. 7, p. m.			1.55	1.47	1.40					
Feb. 8, p. m.			1.49	1.48	1.37		1.10			
Feb. 9, p. m.			1.57	1.45						
Means		[1.54]	1.51	1.45	1.38	1.26	[1.10]		[1.10]	[1.02]
1911.										
Mar. 1, a. m.			1.39	1.30			1.07			
Mar. 4, a. m.		1.60	1.51	1.42	1.33	1.25	1.22			
Mar. 10, a. m.		1.54	1.44	1.39	1.31	1.22				
Mar. 13, a. m.		1.54	1.44	1.35	1.24					
Mar. 14, a. m.		1.48	1.41	1.34	1.28	1.21				
Mar. 17, a. m.					1.27					
Mar. 18, a. m.		1.49		1.25	1.27			1.01	0.94	
Mar. 20, a. m.		1.44	1.38		1.20	1.06	1.00			
Mar. 22, a. m.		1.47			1.24					
Mar. 23, a. m.		1.55		1.45	1.33			1.14		
Mar. 24, a. m.		1.44	1.28	1.15						
Mar. 31, a. m.			1.39							
1912.										
Mar. 1, a. m.		1.47	1.40	1.34	1.26	1.20	1.13	1.06	1.00	
Mar. 5, a. m.		1.36	1.35	1.28	1.19	1.11	1.04			
Mar. 9, a. m.		1.52	1.44	1.36	1.27	1.19	1.12	1.05		
Mar. 15, a. m.		1.58								
Mar. 22, a. m.		1.50	1.40	1.31	1.23	1.15	1.07	1.04		
Mar. 24, a. m.		1.42								
Mar. 28, a. m.		1.32								
Mar. 29, a. m.		1.51	1.42							
Means		1.48	1.40	1.33	1.26	1.17	1.09	1.06	[0.97]	
1911.										
Mar. 4, p. m.			1.45	1.35			1.18	1.12		
Mar. 10, p. m.			1.41	1.30						
Mar. 13, p. m.		1.54	1.44	1.35						
Mar. 14, p. m.		1.46								
Mar. 18, p. m.		1.49	1.36	1.25						
Mar. 20, p. m.		1.44	1.34	1.20						
Mar. 22, p. m.		1.45		1.24						
Mar. 24, p. m.		1.36	1.29	1.22						
1912.										
Mar. 1, p. m.			1.40	1.30						
Mar. 9, p. m.			1.43	1.36	1.27					
Mar. 21, p. m.		1.44	1.36	1.28	1.17					
Mar. 22, p. m.		1.43	1.31							
Mar. 28, p. m.		1.32								
Mar. 29, p. m.		1.50	1.38	1.30	1.22	1.15	1.09	1.03		
Means		1.44	1.38	1.29	1.22	[1.15]	[1.14]	[1.08]		
1911.										
Apr. 1, a. m.		1.54	1.46	1.39	1.29	1.22				
Apr. 7, a. m.		1.46	1.41	1.33	1.24	1.16				
Apr. 9, a. m.				1.07	1.01	0.92				
Apr. 15, a. m.			1.27							

Table 1.—*Madison, Wis.: Solar radiation intensities, expressed in gram-calories per minute per square centimeter of normal surface*—Continued.

Date.	Air mass.									
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
1911.										
Apr. 16, a. m.		1.38	1.26							
Apr. 22, a. m.		1.49	1.39	1.27	1.17					
Apr. 24, a. m.		1.41	1.28	1.18						
1912.										
Apr. 3, a. m.		1.43	1.33	1.27	1.21					
Apr. 5, a. m.		1.18								
Apr. 9, a. m.		1.30	1.18	1.06						
Apr. 10, a. m.		1.26	1.18	1.10						
Apr. 24, a. m.	1.47	1.37	1.29	1.23						
Apr. 27, a. m.	1.58	1.38								
Means	[1.52]	1.38	1.30	1.21	1.18	1.10				
1911.										
Apr. 1, p. m.		1.54	1.34	1.28	1.21	1.12				
Apr. 6, p. m.			1.52							
Apr. 7, p. m.		1.53								
Apr. 14, p. m.		1.46	1.37					0.87	0.81	
Apr. 17, p. m.		1.34								
Apr. 24, p. m.		1.36								
Apr. 25, p. m.		1.30								
1912.										
Apr. 3, p. m.		1.42	1.32	1.24	1.16	1.09	1.02			
Apr. 5, p. m.		1.26	1.16	1.04	0.95					
Apr. 22, p. m.		1.44	1.30							
Apr. 24, p. m.		1.33	1.21							
Apr. 27, p. m.		1.38	1.25							
Means		1.40	1.31	1.19	1.11	[1.10]	[1.02]	[0.87]	[0.81]	
1911.										
May 5, a. m.	1.28	1.12	0.97	0.86	0.77	0.69				
May 6, a. m.	1.37	1.16	1.04	0.93	0.83					
May 7, a. m.			1.09							
May 11, a. m.	1.32									
1912.										
May 9, a. m.	1.49	1.36	1.23	1.11						
Means	1.36	1.21	1.08	0.97	[0.80]	[0.69]				
1911.										
May 5, p. m.		1.12	0.89	0.76						
May 13, p. m.	1.36	1.07								
1912.										
May 9, p. m.		1.30								
Means	[1.36]	1.16	[0.89]	[0.76]						
1911.										
June 19, a. m.	1.18									
June 20, a. m.	1.11	1.02								
June 28, a. m.	1.32	1.26	1.15							
1912.										
June 3, a. m.		1.25	1.15							
June 4, a. m.	1.42	1.31	1.22							
June 6, a. m.		1.33	1.23							
June 7, a. m.		1.32	1.21							
June 27, a. m.		0.84	0.68							
Means	1.26	1.19	1.11							
1911.										
June 19, p. m.		1.12								
Means		[1.12]								

TABLE 2.—*Monthly means of solar radiation intensity at Madison, Wis., for the two year July, 1910, to June, 1912, inclusive.*

Month.	Air mass.								
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
January:									
A. m.			1.44	1.44	1.34			1.12	
P. m.				1.42	1.33	1.24			
February:									
A. m.		1.56	1.49	1.42	1.33	1.26	1.18	1.08	1.15
P. m.			1.51	1.45	1.38	1.26			
March:									
A. m.		1.48	1.40	1.33	1.26	1.17	1.09	1.06	
P. m.		1.44	1.38	1.29	1.22				
April:									
A. m.		1.38	1.30	1.21	1.18	1.10			
P. m.		1.40	1.31	1.19	1.11				
May:									
A. m.	1.36	1.21	1.08	0.97					
P. m.		1.16							
June:									
A. m.	1.26	1.19	1.11						
P. m.									
July:									
A. m.	1.25	1.18	1.08	0.93					
P. m.									
August:									
A. m.	1.33	1.22	1.14	1.07	0.96	0.93	0.86		
P. m.		1.12	0.99	0.82	0.72				
September:									
A. m.		1.23	1.10	1.03	0.96	0.89	0.86		
P. m.		1.24	1.10	1.04	0.95	0.83	0.76	0.74	
October:									
A. m.		1.28	1.17	1.10	1.03	0.92	0.90	0.73	
P. m.			1.21	1.16	1.08				
November:									
A. m.			1.36	1.30	1.26	1.21	1.15	1.05	
P. m.				1.31	1.27				
December:									
A. m.				1.31	1.21	1.15	1.13		
P. m.					1.25				

TABLE 3.—*Monthly means of solar radiation intensity at Washington, D. C., for the five years May, 1905, to April, 1910, inclusive.*

Month.	Air mass.								
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
January:									
A. m.			1.20	1.05	1.05				
P. m.			1.24	1.12	1.04	0.94	0.88	0.83	0.76
February:									
A. m.			1.29	1.16	1.10				
P. m.		1.38	1.23	1.12	1.01	0.95	0.93	0.83	
March:									
A. m.		1.20							
P. m.		1.32	1.14	1.04	1.01	0.91	0.82		
April:									
A. m.	1.41	1.19	1.08	1.02	1.00				
P. m.	1.39	1.20	1.05	0.95	0.88				
May:									
A. m.	1.41	1.17	1.13	0.99					
P. m.	1.26	1.16	1.01	0.87					
June:									
A. m.									
P. m.	1.26	1.08	1.06	0.99	0.88				
July:									
A. m.	1.35	1.21	1.15	1.03	0.95				
P. m.		1.01	0.90						
August:									
A. m.	1.24	1.06							
P. m.		1.04	0.95						
September:									
A. m.		1.30	1.19	1.05	0.95				
P. m.		1.19	1.05	1.01	0.95	0.85			
October:									
A. m.		1.26	1.15	1.06	0.93				
P. m.		1.23	1.14	1.03	0.93	0.84	0.81	0.74	0.65
November:									
A. m.		1.44	1.29	1.20	1.11	0.91			
P. m.		1.45	1.22	1.11	1.02	0.92	0.84	0.82	0.79
December:									
A. m.			1.21	1.15	1.07	1.01	0.97		
P. m.			1.24	1.14	1.06	0.97	0.89	0.88	0.77

TABLE 4.—*Ratio of solar radiation intensities at Madison, Wis., to radiation intensities at Washington, D. C.*

Month.	Air mass.						
	1.0	1.5	2.0	2.5	3.0	3.5	4.0
November:							
A. m.	....	....	1.05	1.08	1.14	1.33	....
P. m.	....	....	....	1.18	1.25	....	....
December:							
A. m.	....	....	....	1.14	1.13	1.14	1.16
P. m.	....	....	....	....	1.19	....	....
January:							
A. m.	....	....	1.20	1.37	1.28	....	....
P. m.	....	....	....	1.27	1.28	1.32	....
February:							
A. m.	....	....	1.16	1.22	1.21	....	....
P. m.	....	....	1.23	1.29	1.37	1.33	....
March:							
A. m.	....	1.23	....	....	....	....	....
P. m.	....	1.09	1.21	1.24	1.21	....	....
April:							
A. m.	....	1.16	1.20	1.19	1.18	....	....
P. m.	....	1.17	1.25	1.25	1.26	....	....

TABLE 5.—*Atmospheric transmission coefficients, a, for Madison, Wis., and Washington, D. C.*

Month.	Air mass.					
	Washington.			Madison.		
	1.5	2.0	2.5	1.5	2.0	2.5
January:						
A. m.	....	0.777	0.775	....	0.852	0.879
P. m.	....	.799	.795	....	....	.874
February:						
A. m.	....	.809	.809	0.854	.870	.877
P. m.	0.789	.790	.798	....	.876	.885
March:						
A. m.	.726	....	....	.835	.849	.860
P. m.	.773	.766	.779	.820	.843	.849
April:						
A. m.	.730	.752	.778	.806	.825	.833
P. m.	.734	.742	.757	.814	.829	.828
May:						
A. m.	.731	.776	.774	.746	.758	.768
P. m.	.725	.733	.735	.725	....	....
June:						
A. m.	....	....	....	.742	.772	....
P. m.	.696	.754	.777	....	....	....
July:						
A. m.	.750	.786	.771	.738	.762	.758
P. m.	.665	.695	....	....	....	....
August:						
A. m.	.692	....	....	.750	.780	.799
P. m.	.675	.712	....	.709	.726	.718
September:						
A. m.	.776	.791	.788	.748	.760	.782
P. m.	.732	.743	.776	.740	.760	.785
October:						
A. m.	.751	.771	.786	.769	.777	.797
P. m.	.739	.767	.777	....	.791	.815
November:						
A. m.	.813	.810	.821	....	.832	.773
P. m.	.816	.788	.796	....	....	.775
December:						
A. m.	....	.781	.804	....	....	.772
P. m.	....	.790	.801	....	....	....

(VIII) FREE-AIR DATA ABOVE MOUNT WEATHER FOR APRIL, MAY, AND JUNE, 1912.

By the Aerial Section, WM. R. BLAIR in charge.

In the 91 days of this period 81 free-air ascensions have been made, all by means of kites. The electrolyser was undergoing repairs during the greater part of the period, consequently no observations were made by means of captive balloons. The mean of the highest points reached daily with the kites was 3,257 meters above sea level in April, 3,261 in May, 2,689 in June, and 3,095 in the period. The highest flight of the period, 5,574 meters above sea level, was made April 25.

The prevailing local wind direction during the three months was northwest. The average wind velocity was 8.6 meters per second in April, 7 in May, 5.6 in June, and 7.1 in the period. Barometric changes during April and May, while of considerable magnitude, were seldom abrupt. The winds accompanying them were therefore good kite-flying winds. For June the barogram is a rather smooth curve and shows variations in air pressure of comparatively small amplitude. The winds of this month were not so favorable for kite flying.

The course of the free-air isotherms, shown in Charts VII to XII, is as a rule rather smooth and in keeping with the barometric changes above described. The lowest and most marked minimum of surface-air pressure in the period passed Mount Weather on the 2d of April. The decided fall in pressure on the 1st and 2d of April is characteristically accompanied by the ascent of the isotherms at all levels reached, while the succeeding marked rise of pressure on the 3d and 4th is attended by their sharp descent. Over the maximum of surface-air pressure the isotherms are rising, their ascent continuing until the succeeding minimum of pressure on the 7th. The relation between the free-air isotherms and the surface-air pressure is exceedingly close and may be followed to very minute fluctuations of the latter. Charts VII to XII show the usual decrease in the number of inversions of temperature observed in these three months from the number observed in the winter months. They also show the increasing smoothness of the isotherms as the summer months approach.

A summary of the absolute humidities for the spring months, similar to that for the winter months shown in volumn V, part 1 of this Bulletin, will appear in a succeeding number of the Bulletin with the 5-year summary of free-air observations at Mount Weather. Sum-

maries of this element for the summer and autumn months, also the observations of wind velocity for the past year, will be shown in the 5-year summary in addition to the temperature and wind direction as tabulated in the 3-year summary.

Figures 14 to 16 show the hourly temperatures at Mount Weather and the valley stations at Trapp and Audley. It is to be kept in mind that Trapp is close to the foot of the mountain range on the east side, while Audley is well out on the valley floor and to the west of the mountain range. The temperatures, as shown for these three months, sustain their characteristic relation to each other. The diurnal range of temperature at Mount Weather is least, while that at Trapp is less than that at Audley. The Trapp temperatures are, on the average, higher for any hour than those at Mount Weather. The Audley temperatures are farthest below those of Mount Weather in the morning hours and farthest above in the early afternoon. The table of cloudiness at Mount Weather for the three months follows:

Month.	Number of days.			Mean cloudiness in tenths.
	Clear.	Partly cloudy.	Cloudy.	
April	7	6	17	6.7
May	13	7	11	5.3
June	4	11	15	5.6

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Apr. 1, 1912:	*mm.*	*°C.*	%		*m. p. s.*	*m.*	*mm.*	*°C.*	%		*m. p. s.*
9:44 a. m.	716.2	12.2	70	se.	7.6	526	716.2	12.2	70	se.	7.6
9:47 a. m.	716.2	12.0	70	se.	8.0	658	705.1	9.0	76	sse.	11.2
9:50 a. m.	716.2	11.8	72	se.	8.5	814	691.9	11.8	68	sse.	11.6
10:16 a. m.	716.0	12.2	68	se.	8.5	930	682.3	12.0	54	ssw.	9.4
12:27 p. m.	714.5	15.0	58	se.	7.2	1,500	636.0	8.7	62	ssw.	12.9
12:41 p. m.	714.2	15.0	60	se.	7.2	3,974	466.5	−8.5	52	sw.	27.5
1:09 p. m.	713.7	15.9	55	se.	9.4	3,533	492.8	−6.9	91	sw.	25.1
1:30 p. m.	713.4	16.1	55	se.	9.4	3,009	526.7	−5.5	89	sw.	21.4
1:51 p. m.	713.0	16.2	54	se.	9.4	2,250	579.2	. 0.9	64	ssw.	22.4
2:05 p. m.	712.8	16.4	55	se.	8.9	1,809	611.3	5.7	53	ssw.	20.2
2;14 p. m.	712.7	16.6	53	se.	9.8	1,345	646.6	9.7	48	s.	18.1
2:22 p. m.	712.6	16.6	53	se.	9.4	1,085	666.8	11.8	45	s.	15.7
2:24 p. m.	712.5	16.5	53	se.	9.4	965	676.4	11.2	48	sse.	16.6
2:27 p. m.	712.5	16.5	53	se.	9.4	864	684.7	11.4	56	sse.	13.3
2:38 p. m.	712.3	16.6	52	se.	9.4	526	712.3	16.6	52	se.	9.4

April 1, 1912.—Seven kites were used; lifting surface, 46.1 sq. m. Wire out, 6,000 m., at maximum altitude.

Ci.-St., from the west, and A.-St., from the southwest, covered the sky until 1:30 p. m. Thereafter there were 10/10 A.-St. and St.-Cu., from the southwest. A solar halo was visible from 11:20 a. m. until 12:50 p. m. The head kite was in A.-St. from 12:51 p. m., altitude 3,900 m., to 1:23 p. m., altitude 3,300 m.

High pressure (768 mm.) was central over southwestern Quebec. Low pressure (754 mm.) was central over northeastern Texas.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Apr. 2, 1912:	*mm.*	*°C.*	*%*		*m.p.s.*	*m.*	*mm.*	*°C.*	*%*		*m.p.s.*
8:34 a. m....	703.3	12.2	100	s.	6.3	526	703.3	12.2	100	s.	6.3
8:45 a. m....	703.2	12.2	100	se.	8.9	936	669.5	10.4	92	sw.	21.5
8:47 a. m....	703.2	12.2	100	se.	8.9	1,148	652.8	13.0	68	sw.	22.3
8:54 a. m....	703.1	12.2	100	se.	11.6	1,538	623.2	11.5	63	sw.	17.2
9:05 a. m....	703.0	12.4	100	se.	6.7	2,020	588.1	8.0	71	wsw.	27.5
9:23 a. m....	702.9	12.6	100	se.	8.5	2,425	559.6	5.0	79	wsw.	28.4
9:48 a. m....	702.7	13.0	99	sw.	8.0	2,076	583.5	7.1	72	wsw.	23.2
9:58 a. m....	702.6	13.4	98	sw.	6.7	1,595	618.4	10.1	73	w.	33.4
10:06 a. m....	702.5	13.4	98	s.	6.3	1,404	632.6	9.4	87	w.	33.6
10:31 a. m....	702.3	13.8	96	s.	5.4	943	668.3	11.8	86	w.	27.5
10:43 a. m....	702.1	14.4	89	s.	6.3	526	702.1	14.4	89	s.	6.3
Apr. 3, 1912:											
8:24 a. m....	712.7	0.0	71	nw.	17.0	526	712.7	0.0	71	nw.	17.0
8:29 a. m....	712.8	0.0	71	nw.	17.4	941	676.5	− 4.7	75	nw.	26.7
8:37 a. m....	712.9	0.4	68	nw.	16.1	1,067	665.8	− 6.0	79	nw.	25.8
8:47 a. m....	713.1	0.4	65	nw.	17.9	1,455	633.7	− 8.7	87	nw.	25.8
8:57 a. m....	713.3	0.1	67	nw.	17.0	1,764	609.0	−10.8	90	nw.	26.7
9:06 a. m....	713.3	0.2	66	nw.	14.8	2,104	582.4	−13.0	88	nw.	25.0
9:15 a. m....	713.4	0.7	62	nw.	18.8	2,456	556.4	−11.5	59	nw.	29.2
9:28 a. m....	713.5	1.0	59	nw.	19.7	2,932	522.8	−12.9	40	nw.	32.7
10:05 a. m....	713.7	0.6	53	nw.	17.0	2,259	571.0	−10.3	31	nw.	30.9
10:10 a. m....	713.8	0.6	52	nw.	17.9	2,046	587.0	−12.3	34	nw.	28.3
10:22 a. m....	713.8	1.1	51	nw.	17.4	1,692	614.8	−11.2	72	nw.	23.2
10:29 a. m....	713.8	0.9	50	nw.	16.5	1,417	637.2	−10.0	82	nw.	22.3
10:40 a. m....	713.9	1.2	52	nw.	14.8	1,050	668.2	− 7.4	75	nw.	22.4
10:52 a. m....	714.0	1.6	50	nw.	16.5	526	714.0	1.6	50	nw.	16.5
Apr. 4, 1912:											
8:03 a. m....	724.4	2.0	52	w.	8.0	526	724.4	2.0	52	w.	8.0
8:17 a. m....	724.5	2.4	49	w.	7.6	1,001	682.9	− 1.2	51	wnw.	15.0
8:35 a. m....	724.6	2.8	47	w.	7.6	1,546	637.8	− 4.1	56	nw.	19.8
8:48 a. m....	724.6	3.4	46	w.	8.5	1,946	606.2	− 5.3	64	nw.	27.5
9:10 a. m....	724.7	3.8	53	w.	10.7	2,772	545.4	− 8.9	70	nw.	28.5
9:43 a. m....	724.8	5.0	49	w.	8.5	3,440	500.4	−12.2	67	nw.	....
10:27 a. m....	724.9	5.7	48	w.	8.0	4,068	460.8	−14.9	71	nw.	....
11:00 a. m....	725.0	7.8	44	w.	7.2	3,827	475.6	−14.1	65	nw.	30.1
11:35 a. m....	724.8	7.4	40	w.	5.4	2,961	532.6	−11.5	81	nw.	29.6
11:50 a. m....	724.7	7.2	38	wsw.	5.8	2,776	545.4	−10.1	79	nw.	28.5
12:09 p. m...	724.7	7.8	40	w.	4.9	2,016	601.5	− 6.9	53	nw.	24.6
12:20 p. m...	724.6	8.8	36	w.	5.4	1,026	681.7	1.1	53	nw.	9.3
12:25 p. m...	724.6	9.0	35	w.	5.8	526	724.6	9.0	35	w.	5.8

April 2, 1912.—Two kites were used; lifting surface, 12.6 sq. m. Wire out, 3,500 m.; at maximum altitude, 3,400 m.

There was dense fog until 9:36 a. m. A.-Cu., from the west, and St., from the south, almost covered the sky after 10 a. m.

A trough of low pressure (749 mm.) extended from northern Virginia to Kentucky. Pressure was high over the Atlantic.

April 3, 1912.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 4,400 m.; at maximum altitude, 4,300 m.

There were 7/10 to 3/10 St.-Cu., from the northwest. The head kite entered the clouds at 8:40 a. m., altitude 1,200 m., and emerged at 10:26 a. m., altitude 1,500 m. Snow fell from 9:23 to 10 a. m.

Low pressure was central over Nova Scotia (742 mm.) and high pressure over Texas (770 mm.).

April 4, 1912.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 8,000 m., at maximum altitude.

A.-Cu., from the northwest, decreased from 2/10 to none before 8:30 a. m., and after 10:30 a. m. varied from 1/10 to 8/10.

High pressure (775 mm.), central over North Carolina, covered the eastern half of the United States. Low pressure (757 mm.) was central over Newfoundland.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Apr. 5, 1912:	*mm.*	°*C.*	%		*m.p.s.*	*m.*	*mm.*	°*C.*	%		*m.p.s*
8:06 a. m....	722.1	12.8	35	w.	13.9	526	722.1	12.8	35	w.	13.9
8:10 a. m....	722.1	12.8	34	w.	13.9	972	684.9	13.6	27	w.	21.5
8:23 a. m....	722.1	15.3	19	w.	13.4	1,501	643.3	9.7	27	wnw.	14.6
8:40 a. m....	722.1	14.5	29	w.	10.7	2,167	593.2	2.7	34	wnw.	17.2
8:54 a. m....	722.1	14.6	25	w.	10.7	2,666	557.4	− 2.3	38	w.	16.8
9:23 a. m....	721.9	18.4	......	w.	10.7	2,996	534.8	− 5.1	44	wsw.	14.3
9:43 a. m....	721.9	15.6	29	w.	9.8	3,401	507.4	− 9.7	50	wsw.	13.3
10:03 a. m....	721.8	15.6	31	w.	9.4	3,581	495.7	−10.5	54	wsw.	25.8
10:09 a. m....	721.8	16.0	29	w.	9.4	3,728	486.4	−10.4	50	wsw.	20.6
10:36 a. m....	721.7	17.3	27	w.	8.0	4,357	447.8	−13.6	44	w.	28.0
11:28 a. m....	721.7	19.2	27	w.	10.3	3,675	489.1	−11.5	42	wsw.	24.7
11:48 a. m....	721.2	19.4	27	w.	9.8	3,160	522.4	− 8.8	46	wsw.	21.5
12:08 p. m....	720.8	19.6	29	w.	8.9	2,893	540.1	− 6.7	50	wsw.	18.3
12:24 p. m...	720.7	19.6	29	wsw.	8.9	1,901	611.6	3.4	50	w.	17.2
12:39 p. m...	720.6	19.9	25	w.	6.3	1,500	642.1	8.5	46	w.	12.0
12:52 p. m...	720.5	19.6	26	w.	10.7	960	684.9	14.0	37	w.	16.8
1:06 p. m...	720.3	19.8	26	w.	8.9	526	720.3	19.8	26	w.	8.9
Apr. 6, 1912:											
8:01. a. m...	719.0	16.8	39	wsw.	6.7	526	719.0	16.8	39	wsw.	6.7
8:13 a. m....	719.0	17.2	39	wsw.	6.7	858	691.5	14.5	37	w.	11.2
8:30 a. m....	718.9	17.3	38	w.	6.7	1,379	649.8	10.3	42	wnw.	18.7
9:24 a. m....	718.7	18.2	38	wsw.	8.0	1,879	612.0	8.0	40	wnw.	8.8
9:50 a. m....	718.6	18.6	39	wsw.	8.0	2,778	547.6	− 0.4	45	sw.	17.2
10:05 a. m....	718.6	19.0	39	w.	7.2	2,235	585.5	2.8	46	sw.	15.5
10:25 a. m....	718.5	19.2	36	sw.	5.4	1,424	646.2	8.8	46	w.	15.0
10:34 a. m....	718.4	19.6	37	sw.	.5.4	823	693.9	15.9	40	ssw.	11.2
10:43 a. m....	718.4	19.9	38	sw.	5.4	526	718.4	19.9	38	sw.	5.4
Apr. 7, 1912:											
8:07 a. m....	712.2	12.7	79	sse.	5.4	526	712.2	12.7	79	sse.	5.4
8:16 a. m....	712.1	12.8	79	sse.	5.4	873	683.3	12.2	74	wsw.	24.9
8:28 a. m....	712.1	13.2	77	sse.	4.9	1,399	641.6	9.2	80	sw.	21.9
8:41 a. m....	712.1	13.8	74	sse.	4.9	1,803	611.0	7.1	88	sw.	19.8
8:56 a. m....	712.0	13.4	77	sse.	7.6	2,585	555.0	0.3	92	sw.	23.2
9:05 a. m....	712.0	13.1	80	sse.	6.7	3,105	519.4	− 2.6	96	sw.	28.9
9:30 a. m....	712.0	12.6	85	sse.	6.3	2,104	587.8	2.7	96	sw.	23.3
9:56 a. m....	711.9	12.4	91	s.	6.7	1,478	634.5	5.2	93	sw.	....
10:12 a. m....	711.8	12.8	91	sse.	6.7	924	678.5	7.9	82	sw.	21.3
10:19 a. m....	711.8	12.8	89	s.	6.7	526	711.8	12.8	89	s.	6.7

April 5, 1912.—Seven kites were used; lifting surface, 44.1 sq. m. Wire out, 8,000 m.; at maximum altitude, 7,850 m.

There were 10/10 to 8/10 Ci.-St., from the west-southwest until about 10:30 a. m. and from the west thereafter, and St. Cu., from the west-northwest. A solar halo was visible from 9:30 to 10:35 a. m.

Low pressure (750 mm.) was central over eastern North Dakota. High pressure (775 mm.) was central on the Carolina coast.

April 6, 1912.—Six kites were used; lifting surface, 39.8 sq. m. Wire out, 4,800 m.; at maximum altitude, 3,500 m.

Ci.-St., from the west-northwest, increased from none to 4/10.

High pressure (772 mm.) was central east of the south Atlantic coast. Low pressure (746 mm.) was central over Wisconsin.

April 7, 1912.—Four kites were used; lifting surface, 27.2 sq. m. Wire out, 4,000 m.; at maximum altitude, 3,800 m.

The sky was covered with A.-St. and St.-Cu. from the southwest. The head kite entered St.-Cu., altitude 2,600 m., at 9 a. m., and reappeared at 9:29 a. m., altitude 2,100 m. Rain fell from 8:41 to 10:19 a. m.

Low pressure (751 mm.) was central over east Ontario. High pressure (772 mm.) was central over Kansas and pressure was high (772 mm.) east of the middle Atlantic coast.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Apr. 8, 1912:	*mm.*	*°C.*	%		*m.p.s.*	*m.*	*mm.*	*°C.*	%		*m.p.s.*
1:17 p. m...	719.6	4.0	43	wnw.	17.9	526	719.6	4.0	43	wnw.	17.9
1:23 p. m...	719.6	3.8	50	wnw.	16.1	821	693.8	0.6	48	nw.	19.8
1:38 p. m...	719.6	3.6	45	wnw.	17.9	1,230	659.1	− 4.0	60	nw.	20.6
1:43 p. m...	719.6	3.8	42	wnw.	18.8	1,694	621.2	− 8.1	70	nw.	24.9
1:52 p. m...	719.5	3.9	42	wnw.	17.9	2,319	572.7	−13.0	74	nw.	34.4
2:05 p. m...	719.5	4.2	43	wnw.	17.9	2,653	548.1	−13.2	62	nw.	41.3
2:25 p. m...	719.4	4.3	46	wnw.	14.3	2,043	593.2	−11.8	82	nw.	25.8
2:42 p. m...	719.2	4.6	42	wnw.	14.8	1,572	630.6	− 9.0	78	nw.	21.5
3:07 p. m...	719.0	5.6	37	wnw.	17.9	1,280	654.3	− 4.6	62	nw.	24.1
3:22 p. m...	718.9	5.5	39	wnw.	14.3	856	690.2	0.2	50	nw.	21.5
3:29 p. m...	718.8	5.8	38	wnw.	14.3	526	718.8	5.8	38	wnw.	14.3
Apr. 9, 1912:											
8:00 a. m....	718.7	7.6	47	w.	8.5	526	718.7	7.6	47	w.	8.5
8:08 a. m....	718.6	7.7	47	w.	8.5	909	685.9	5.4	49	wnw.	17.2
8:22 a. m....	718.4	8.2	40	w.	8.9	1,389	646.6	4.4	45	wnw.	16.8
8:38 a. m....	718.3	8.5	44	w.	8.9	2,125	590.4	− 0.9	54	w.	22.4
8:57 a. m....	718.0	9.1	42	w.	10.7	3,272	510.6	− 5.7	58	wnw.	31.0
9:10 a. m....	718.0	9.4	41	w.	9.8	3,530	494.0	− 8.6	59	wnw.	30.1
9:28 a. m....	717.9	10.0	41	wsw.	8.0	3,912	470.2	−11.1	58	wnw.	31.0
9:39 a. m....	717.8	11.1	39	sw.	9.4	4,231	450.8	−13.5	53	wnw.	31.8
10:15 a. m....	717.5	12.0	39	sw.	6.7	3,738	480.5	−11.3	49	w.	29.3
10:32 a. m....	717.2	12.6	39	sw.	6.7	3,360	504.5	− 9.8	61	w.	28.4
10:47 a. m....	717.0	13.2	40	sw.	5.4	2,999	528.3	− 7.0	61	w.	29.0
11:10 a. m....	716.6	14.0	39	sw.	5.8	2,370	572.1	− 1.6	54	w.	30.1
11:27 a. m....	716.3	14.2	40	sw.	6.7	1,530	634.7	4.1	48	w.	21.5
11:40 a. m....	716.1	14.4	36	sw.	6.3	932	682.3	9.3	45	sw.	13.8
11:48 a. m....	715.9	14.6	35	sw.	5.4	526	715.9	14.6	35	sw.	5.4
Apr. 10, 1912:											
8:08 a. m....	711.7	12.8	44	wnw.	17.9	526	711.7	12.8	44	wnw.	17.9
8:18 a. m....	711.8	12.9	44	wnw.	17.9	1,017	671.2	8.1	55	wnw.	....
8:26 a. m....	711.8	13.1	45	wnw.	18.8	1,195	656.8	6.6	60	wnw.	....
8:37 a. m....	711.8	12.8	45	wnw.	21.5	1,740	614.3	0.5	76	wnw.	....
8:49 a. m....	711.9	13.0	45	wnw.	21.5	2,203	579.7	− 3.4	90	wnw.	....
9:00 a. m....	711.9	13.3	46	wnw.	13.4	2,644	548.4	− 3.6	84	wnw.	26.7
9:21 a. m....	712.0	13.4	46	wnw.	8.0	3,422	496.5	− 9.6	94	wnw.	28.2
10:00 a. m....	712.3	13.1	51	wnw.	8.9	4,072	455.9	−12.8	72	wnw.	32.7
10:32 a. m....	712.4	12.2	54	nw.	9.4	2,930	527.9	− 8.5	58	wnw.	....
11:03 a. m....	712.5	11.8	58	wnw.	10.3	2,371	567.2	− 3.8	90	wnw.	29.2
11:27 a. m....	712.5	12.0	60	wnw.	13.9	1,798	609.6	− 1.9	94	wnw.	21.0
11:48 a. m....	712.5	11.8	60	wnw.	13.0	1,182	658.0	3.4	78	wnw.	19.8
12:00 noon...	712.5	11.8	60	wnw.	17.9	934	678.3	5.9	70	wnw.	21.5
12:09 p. m....	712.5	11.9	63	nw.	17.4	526	712.5	11.9	63	nw.	17.4

April 8, 1912.—Four kites were used; lifting surface, 21.4 sq. m. Wire out, 4,000 m. at maximum altitude.

There were 6/10 decreasing to 4/10 Cu., from the northwest. The head kite was in Cu. at intervals about 1:50 p. m.; approximate altitude, 2,150 m.

High pressure (774 mm.) was central over the middle Mississippi Valley. Low pressure (751 mm.) was central over the lower St. Lawrence Valley.

April 9, 1912.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 7,000 m., at maximum altitude.

The sky was cloudless, except a few Ci.-Cu., from the west, from 8:15 to 11 a. m.

High pressure (771 mm.) was central over the Carolinas. Low pressure was central over Lake Michigan (755 mm.) and over Newfoundland (754 mm.).

April 10, 1912.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 7,500 m., at maximum altitude.

The sky was covered with A.-Cu., from the west, and St.-Cu., from the west-northwest, until 9 a. m.; thereafter with St.-Cu. The head kite came out of St.-Cu., altitude 1,800 m., at 11:34 a. m.

High pressure was central over the Upper Tennessee Valley (765 mm.) and central Michigan (765 mm.). Low pressure (756 mm.) covered the New England coast.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Apr. 11, 1912:	*mm.*	*°C.*	%		*m.p.s.*	*m.*	*mm.*	*°C.*	%		*m.p.s.*
10:55 a.m.	716.6	12.5	53	sse.	6.7	526	716.6	12.5	53	sse.	6.7
12:27 p.m.	715.9	15.0	39	sse.	8.9	1,699	622.3	7.2	36	w.	11.8
12:57 p.m.	715.6	16.0	45	sse.	6.3	2,378	572.7	1.7	43	w.	19.8
1:17 p.m.	715.4	17.1	35	sse.	7.6	3,106	522.6	− 4.1	47	w.	22.4
1:36 p.m.	715.3	17.7	35	sse.	7.6	3,753	481.3	− 9.9	51	w.	25.0
1:58 p.m.	715.2	18.2	34	sse.	8.5	4,551	433.8	−13.6	44	wnw.	28.0
2:20 p.m.	715.0	18.8	32	sse.	8.9	4,998	408.4	−16.0	34	wnw.	26.7
2:44 p.m.	714.8	19.3	32	sse.	8.0	4,672	426.0	−14.2	30	wnw.	25.9
3:06 p.m.	714.6	19.5	30	sse.	9.4	4,182	454.4	−12.7	28	wnw.	24.9
3:45 p.m.	714.3	20.2	26	sse.	8.5	3,311	508.3	− 7.6	32	w.	27.5
4:12 p.m.	714.1	20.2	24	sse.	10.3	2,746	546.1	− 3.5	56	w.	20.6
4:34 p.m.	714.0	19.5	27	sse.	6.7	1,987	600.1	5.1	49	wsw.	16.4
4:45 p.m.	714.0	19.0	26	sse.	6.7	1,254	655.3	12.3	42	sw.	16.8
4:58 p.m.	714.0	18.6	30	s.	5.4	848	687.6	14.9	36	s.	13.8
5:06 p.m.	714.0	18.6	30	s.	5.4	526	714.0	18.6	30	s.	5.4
Apr. 12, 1912:											
1:20 p.m.	713.5	23.0	27	sse.	7.6	526	713.5	23.0	27	sse.	7.6
1:42 p.m.	713.3	24.0	27	sse.	7.6	921	681.6	19.1	32	s.	9.7
2:28 p.m.	712.9	23.3	32	s.	7.2	1,519	635.1	12.8	43	ssw.	11.2
3:39 p.m.	712.0	24.0	27	s.	6.7	1,889	606.9	10.0	44	ssw.	10.5
3:55 p.m.	711.7	24.0	27	s.	5.8	2,354	573.5	4.8	58	sw.	15.5
4:06 p.m.	711.6	24.3	27	s.	5.8	3,084	524.0	− 1.9	68	sw.	18.9
4:20 p.m.	711.6	24.6	28	s.	5.8	3,597	490.7	− 6.4	72	sw.	22.4
4:59 p.m.	711.6	23.8	30	s.	6.3	4,294	448.3	−12.5	84	w.	23.2
5:20 p.m.	711.6	23.6	30	s.	7.2	3,750	481.0	− 9.7	82	w.	22.3
5:37 p.m.	711.5	23.4	31	s.	6.3	3,192	516.6	− 4.4	88	wsw.	21.5
5:49 p.m.	711.5	23.1	32	s.	6.3	2,836	540.1	− 0.4	80	sw.	20.5
6:02 p.m.	711.5	22.6	34	ssw.	5.4	2,157	587.2	7.1	65	sw.	17.4
6:15 p.m.	711.5	21.8	41	sw.	8.0	1,391	643.4	14.5	50	sw.	15.9
6:29 p.m.	711.5	20.2	46	w.	6.3	526	711.5	20.2	46	w.	6.3
Apr. 13, 1912:											
6:30 a.m.	711.4	9.8	95	ese.	7.6	526	711.4	9.8	95	ese.	7.6
6:46 a.m.	711.5	9.6	95	ese.	6.7	644	701.6	15.7	73	sse.	8.2
7:14 a.m.	711.7	9.2	98	ese.	5.4	720	695.6	15.7	71	sse.	5.9
7:25 a.m.	711.8	9.2	98	ese.	4.0	855	684.8	14.7	73	sse.	5.4
7:30 a.m.	711.9	9.2	98	ese.	4.0	526	711.9	9.2	98	ese.	4.0

April 11, 1912.—Seven kites were used; lifting surface, 46.1 sq. m. Wire out, 8,000 m., at maximum altitude.

The sky was cloudless.

High pressure (765 mm.) was central over Maryland. Low pressure (752 mm.) was central over Newfoundland.

April 12, 1912.—Six kites were used; lifting surface, 38.3 sq. m. Wire out, 6,500 m.; at maximum altitude, 6,300 m.

St.-Cu., from the west-southwest, varied from a few to 6/10 before 5:30 p. m. Thereafter the sky was covered with St.-Cu. and Cu.-Nb., from the west-southwest. The head kite was in St.-Cu., altitude 3,500 m., at 5:28 and 5:32 p. m. Thunderstorms, moving from southwest to northeast, passed north and south of the station; first thunder was heard at 5:37 p. m. Rain fell from 5:37 to 5:54 p. m. and after 6:14 p. m.

At 8 a. m. pressure was high (765 mm.) off the southern Atlantic coast. Pressure was low (754 mm.) over Newfoundland.

April 13, 1912.—Two kites were used; lifting surface, 13.1 sq. m. Wire out, 740 m.; at maximum altitude, 550 m.

The sky was covered with St., from the east-southeast. There was light fog.

Low pressure (738 mm.) was central over western Nebraska. Pressure was high (768 mm.) over Quebec.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Apr. 14, 1912:	*mm.*	*°C.*	*%*		*m.p.s.*	*m.*	*mm.*	*°C.*	*%*		*m.p.s.*
10:51 a. m....	718.8	7.0	100	sse.	6.7	526	718.8	7.0	100	sse.	6.7
11:03 a. m....	718.8	7.1	100	sse.	5.8	1,006	678.5	11.4	66	s.	20.6
11:13 a. m....	718.8	7.6	100	sse.	5.8	1,579	633.4	9.2	89	ssw.	16.8
11:31 a. m....	718.8	7.4	100	sse.	7.6	1,813	615.7	7.3	92	ssw.	10.3
11:38 a. m....	718.8	7.5	100	sse.	8.5	1,954	605.2	7.0	92	ssw.	9.5
11:52 a. m....	718.8	7.5	100	sse.	8.5	2,416	572.0	3.7	99	ssw.	10.7
12:12 p. m...	718.8	7.5	100	sse.	8.9	1,564	634.5	8.5	82	ssw.	17.2
12:28 p. m...	718.8	7.8	100	sse.	6.7	992	679.7	10.9	94	s.	19.8
12:33 p. m...	718.8	7.9	100	sse.	8.0	526	718.8	7.9	100	sse.	8.0
Apr. 15, 1912:											
9:59 a. m....	719.2	14.4	100	sse.	8.9	526	719.2	14.4	100	sse.	8.9
10:03 a. m....	719.2	14.4	100	s.	8.0	858	691.5	13.9	100	ssw.	25.8
10:10 a. m....	719.2	14.5	100	s.	9.4	963	683.1	16.6	73	ssw.	15.7
10:48 a. m....	719.0	15.0	100	sse.	7.6	1,111	671.2	17.3	57	ssw.	9.0
11:04 a. m....	718.9	16.0	98	sse.	6.3	1,671	628.5	12.6	78	sw.	16.8
11:09 a. m....	718.8	16.4	97	sse.	6.3	2,131	594.8	10.5	64	sw.	28.4
11:22 a. m....	718.8	16.9	93	sse.	6.7	2,518	567.6	5.7	70	wsw.	19.9
11:41 a. m....	718.6	17.7	89	sse.	6.3	2,856	544.6	4.5	66	wsw.	27.3
11:58 a. m....	718.5	18.4	85	s.	6.3	3,317	514.3	−0.1	64	w.	30.6
12:09 p. m...	718.4	19.1	83	se.	7.2	4,119	464.7	−6.4	61	w.	31.6
12:25 p. m...	718.1	20.2	77	se.	7.2	3,422	507.2	−2.2	54	w.	29.2
12:52 p. m...	717.6	21.2	70	se.	8.9	2,927	539.1	2.0	......	w.	26.5
1:15 p. m...	717.4	21.6	70	se.	9.8	2,503	567.6	6.3	59	wsw.	25.8
1:24 p. m...	717.3	21.9	68	se.	11.6	2,098	596.0	9.2	57	wsw.	23.4
1:39 p. m...	717.2	21.4	70	se.	10.7	1,575	634.4	13.5	54	wsw.	15.5
1:46 p. m...	717.1	21.7	69	se.	11.2	1,401	647.4	14.6	62	wsw.	18.1
1:47 p. m...	717.1	21.6	69	se.	11.2	1,233	660.4	13.8	66	sw.	16.4
1:57 p. m...	717.0	21.0	71	se.	11.6	914	685.5	17.3	85	s.	20.2
2:02 p. m...	717.0	21.6	70	se.	10.3	526	717.0	21.6	70	se.	10.3
Apr. 16, 1912:											
2:38 p. m....	714.2	22.2	68	sse.	6.7	526	714.2	22.2	68	sse.	6.7
3:02 p. m....	714.0	22.2	67	se.	5.4	804	691.5	19.4	73	sse.	9.0
3:37 p. m....	714.0	22.4	64	se.	6.3	1,121	666.4	16.4	80	s.	10.8
3:59 p. m....	714.0	22.4	61	sse.	6.3	1,432	642.6	14.9	78	s.	9.0
4:14 p. m....	714.0	21.5	65	sse.	7.2	1,661	626.0	12.9	76	s.	10.0
4:20 p. m....	714.0	21.4	66	s.	5.4	1,397	645.0	13.9	83	s.	14.2
4:30 p. m....	714.0	21.2	66	s.	7.2	878	685.5	17.1	77	s.	15.5
4:37 p. m....	714.0	21.1	68	sse.	7.2	526	714.0	21.1	68	sse.	7.2

April 14, 1912.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 3,600 m.; at maximum altitude, 2,800 m.

There was dense fog during the flight.

High pressure (775 mm.) was central over New Brunswick. Low pressure (742 mm.) was central over eastern North Dakota.

April 15, 1912.—Seven kites were used; lifting surface, 44.1 sq. m. Wire out, 7,000 m.; at maximum altitude, 6,600 m.

Dense fog partly lifted about 10:30 a. m. and wholly lifted about 11 a. m., revealing very low St. from the south, which dissipated by 11.30 a. m. and were followed by 2/10 to 4/10 St.-Cu. from the west-southwest. The head kite left the St.-Cu. layer at 1:46 p. m.; altitude, 1,400 m. After 11 a. m. few to 4/10 Ci. St., from the west-southwest were visible.

Pressure was high (774 mm.) off Nova Scotia and low pressure (752 mm.) was central over Wisconsin.

April 16, 1912.—Four kites were used; lifting surface, 30.1 sq. m. Wire out, 2,200 m.; at maximum altitude, 1,350 m.

There were from 5/10 to 6/10 Cu. and Cu.-Nb., from the west. Thunder was heard first at 3:58 p. m.; rain fell after 4:35 p. m.

Low pressure (756 mm.) was central over the lower St. Lawrence, and high pressure (772 mm.) was central over Manitoba. Pressure was high (767 mm.) east of the middle Atlantic coast.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Apr. 18, 1912:	*mm.*	*°C.*	*%*		*m.p.s.*	*m.*	*mm.*	*°C.*	*%*		*m.p.s.*
1:02 p.m....	706.5	10.1	100	se.	8.9	526	706.5	10.1	100	se.	8.9
1:05 p.m....	706.5	10.2	100	se.	7.6	663	695.1	10.0	97	s.	12.4
1:17 p.m....	706.5	10.2	100	se.	8.5	854	679.4	14.9	70	ssw.	12.2
1:23 p.m....	706.5	10.2	100	se.	8.0	1,343	641.2	12.1	72	ssw.	13.8
1:41 p.m....	706.5	10.4	100	se.	8.0	1,961	595.2	7.1	78	sw.	18.1
2:02 p.m....	706.5	10.6	100	se.	6.7	2,427	561.9	3.3	67	sw.	20.2
2:18 p.m....	706.4	11.0	100	se.	4.5	1,680	615.1	8.4	72	sw.	18.9
2:21 p.m....	706.4	11.0	100	se.	1.8	1,271	645.9	11.1	74	sw.	11.1
2:24 p.m....	706.4	11.0	100	w.	1.8	821	681.8	9.1	96	w.	13.3
2:26 p.m....	706.4	11.0	100	w.	1.8	526	706.4	11.0	100	w.	1.8
Apr. 19, 1912:											
8:26 a.m....	711.7	3.4	75	w.	10.7	526	711.7	3.4	75	w.	10.7
8:35 a.m....	711.7	3.4	75	wnw.	12.5	920	677.7	− 0.9	88	wnw.	18.9
8:41 a.m....	711.8	3.4	75	w.	14.8	1,207	653.8	− 3.4	94	wnw.	21.5
9:05 a.m....	711.8	3.6	73	wnw.	17.0	1,528	627.8	− 4.8	94	wnw.	24.3
9:15 a.m....	711.9	3.9	74	wnw.	17.4	1,753	610.2	− 3.6	92	nw.	33.8
9:26 a.m....	711.9	4.4	72	wnw.	17.9	2,215	575.6	− 4.5	72	nw.	32.5
9:34 a.m....	712.0	4.6	72	wnw.	16.1	2,529	553.2	− 3.2	61	nw.	25.8
9:57 a.m....	712.1	4.6	72	wnw.	17.4	2,992	521.9	− 4.1	52	nw.	21.5
10:12 a.m....	712.2	4.8	73	wnw.	16.5	3,312	501.4	− 4.6	40	nw.	25.8
10:34 a.m....	712.5	5.3	69	wnw.	17.9	3,301	502.3	− 6.0	49	nw.	25.7
10:57 a.m....	712.8	4.8	72	wnw.	17.0	2,938	526.1	− 3.5	43	nw.	29.2
11:06 a.m....	712.8	4.7	74	wnw.	13.4	2,748	538.9	− 3.4	36	nw.	33.5
11:26 a.m....	713.1	4.7	73	wnw.	15.6	2,261	573.4	− 2.1	34	nw.	31.7
11:36 a.m....	713.2	4.8	72	wnw.	16.1	2,139	582.4	− 3.8	34	nw.	......
11:39 a.m....	713.2	4.7	72	wnw.	......	1,968	595.1	− 3.1	51	nw.	24.4
11:42 a.m....	713.2	4.5	71	wnw.	14.3	1,769	610.2	− 4.6	59	nw.	24.4
11:47 a.m....	713.3	4.4	71	wnw.	17.9	1,429	637.2	− 3.8	89	nw.	24.1
12:01 p.m....	713.4	4.6	72	wnw.	17.0	983	674.1	− 1.6	96	wnw.	20.6
12:14 p.m....	713.5	4.1	72	wnw.	16.1	526	713.5	4.1	72	wnw.	16.1
Apr. 20, 1912:											
2:31 p.m....	718.0	11.8	48	s.	5.4	526	718.0	11.8	48	s.	5.4
3:47 p.m....	717.6	12.1	49	sse.	6.3	1,152	673.6	6.5	54	ssw.	9.9
5:05 p.m....	717.6	11.6	52	sse.	5.4	1,362	648.6	4.6	55	sw.	9.1
5:50 p.m....	717.8	11.3	53	sse.	6.3	1,664	625.0	2.7	58	sw.	8.6
6:02 p.m....	717.8	11.6	49	sse.	4.9	2,703	549.0	− 2.2	66	wsw.	16.0
6:25 p.m....	717.8	10.8	56	s.	4.9	1,736	619.2	0.7	68	sw.	9.5
6:36 p.m....	717.8	10.7	57	sse.	4.9	1,258	656.9	4.9	62	ssw.	6.9
6:45 p.m....	717.8	10.8	56	s.	4.9	923	684.3	7.0	60	s.	11.6
6:52 p.m....	717.8	10.6	58	sse.	4.5	526	717.8	10.6	58	sse.	4.5

April 18, 1912.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 3,000 m.; at maximum altitude, 2,450 m.

There was a dense fog during the flight. Distant thunder was heard at 1:43 p. m.

High pressure (767 mm.) was central over South Dakota and over Nova Scotia. Low pressure (752 mm.), was central over eastern Michigan.

April 19, 1912.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 7,000 m. at maximum altitude.

There were 10/10 St.-Cu., from the west-northwest. The head kite was in St.-Cu., altitude 1,200 m., from 8:39 to 8:43 a. m., and reentered at 8:57 and emerged at 11:59 a. m.

High pressure (767 mm.) was central over Tennessee. Low pressure (747 mm.) was central over New Brunswick.

April 20, 1912.—Five kites were used; lifting surface, 37.4 sq. m. Wire out, 4,000 m.; at maximum altitude, 2,900 m.

There were 10/10 Ci.-St., from the southwest, followed by 8/10 A.-St. from the southwest, by 4:40 p. m. These decreased to few by 6 p. m. At 5:30 p. m. there were also 3/10 Ci., from the west-southwest. A solar halo was observed at 2:45 p. m.

High pressure (767 mm.) was central over southern New Jersey. Low pressure was central over Colorado (748 mm.) and over Newfoundland (737 mm.).

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Apr. 21, 1912:	*mm.*	*°C.*	*%*		*m. p. s.*	*m.*	*mm.*	*°C.*	*%*		*m. p. s.*
10:20 a. m....	717.8	7.8	100	se.	9.4	526	717.8	7.8	100	se.	9.4
10:22 a. m....	717.8	7.8	100	se.	9.4	751	698.5	7.1	97	sse.	21.0
10:29 a. m....	717.8	7.8	100	se.	8.9	938	682.9	8.4	83	s.	19.8
11:10 a. m....	717.8	8.6	100	se.	8.0	1,219	660.2	8.9	71	s.	9.9
11:17 a. m....	717.8	8.8	100	se.	8.5	2,030	598.0	2.9	88	s.	15.5
11:28 a. m....	717.8	9.0	100	se.	8.9	1,751	618.9	4.3	83	s.	12.8
11:37 a. m....	717.8	9.3	100	se.	10.3	1,250	657.8	9.6	70	s.	13.3
11:48 a. m....	717.8	9.3	100	se.	9.8	939	682.9	8.8	83	s.	21.1
11:52 a. m....	717.8	9.5	100	se.	9.8	781	696.1	7.8	95	sse.	18.4
11:57 a. m....	717.8	9.9	98	se.	11.2	526	717.8	9.9	98	se.	11.2
Apr. 22, 1912:											
10:13 a. m....	709.9	11.2	100	sse.	7.2	526	709.9	11.2	100	sse.	7.2
10:21 a. m....	710.0	11.2	100	sse.	6.3	942	675.4	9.2	100	ssw.	18.1
10:31 a. m....	710.1	11.2	100	ssw.	6.3	1,180	656.3	8.4	99	sw.	11.2
11:09 a. m....	710.3	11.6	98	sw.	7.2	1,353	643.1	11.4	70	sw.	12.0
11:20 a. m....	710.3	12.6	90	wsw.	5.4	2,425	565.1	5.1	74	wsw.	21.0
11:36 a. m....	710.2	12.8	87	wsw.	5.8	2,930	530.6	0.2	90	wsw.	26.7
11:57 a. m....	710.2	12.2	94	sse.	6.3	2,529	557.1	1.7	92	sw.	24.9
12:16 p. m....	709.7	12.0	98	se.	5.4	2,056	590.3	3.7	93	sw.	24.9
12:33 p. m....	709.2	12.4	100	se.	4.9	1,561	626.6	8.0	88	sw.	24.9
12:47 p. m....	708.8	12.2	98	se.	5.4	1,006	669.4	11.4	84	wsw.	23.2
12:54 p. m....	708.6	12.0	98	se.	6.3	526	708.6	12.0	98	se.	6.3
Apr. 23, 1912:											
1:18 p. m....	715.4	10.2	32	wnw.	18.8	526	715.4	10.2	32	wnw.	18.8
1:24 p. m....	715.4	9.9	32	wnw.	17.9	896	684.0	4.7	34	wnw.	22.4
1:34 p. m....	715.4	10.3	31	nw.	17.4	1,316	649.4	0.1	41	nw.	24.1
2:04 p. m....	715.5	10.8	26	nw.	17.9	2,039	593.0	− 6.2	50	nw.	30.1
2:10 p. m....	715.5	10.8	27	nw.	21.5	2,223	579.2	− 5.9	47	nw.	28.6
2:18 p. m....	715.5	10.8	29	nw.	17.9	2,502	558.9	− 6.5	29	nw.	36.3
2:39 p. m....	715.6	10.8	28	nw.	21.5	2,910	530.4	−10.2	19	nw.	34.4
4:25 p. m....	715.6	10.8	28	wnw.	20.6	526	715.6	10.8	28	wnw.	20.6

April 21, 1912.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 3,500 m.; at maximum altitude, 2,600 m.

There was dense fog.

A well-developed low (746 mm.) was central over western Iowa, and there was a small low (760 mm.) off the North Carolina coast. Pressure was relatively high (767 mm.) over New Jersey.

April 22, 1912.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 4,000 m.; maximum altitude, 3,700 m.

At the beginning there were 10/10 St., from the south-southwest, and light fog. After 11:10 a. m., there were from 10/10 to 8/10 A.-St. and St.-Cu., from the west-southwest. After noon, there were 10/10 St., altitude 600 m., from the south. The head kite entered St.-Cu., altitude about 2,500 m., at 11:25 and reappeared at 11:43 a. m. Rain fell after 10:55 a. m.

Low pressure (746 mm.) central over Lake Huron, covered the eastern half of the United States. High pressure (767 mm.) was central over Nova Scotia.

April 23, 1912.—Four kites were used; lifting surface, 21.4 sq. m. Wire out, 5,500 m., at maximum altitude.

There were a few Cu., from the northwest, during the flight. The head kite was momentarily in Cu. at 2:43 p. m., altitude 2,800 m.

Low pressure (738 mm.) was central over New Brunswick, and high pressure (770 mm.) was central over Arkansas.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Apr. 24, 1912:	*mm.*	*°C.*	%		*m.p.s.*	*m.*	*mm.*	*°C.*	%		*m.p.s.*
6:12 a. m....	721.1	8.5	39	w.	8.9	526	721.1	8.5	39	w.	8.9
6:21 a. m....	721.1	8.7	39	wsw.	9.4	994	681.3	6.4	41	wnw.	18.1
6:32 a. m....	721.1	9.1	38	wsw.	8.9	1,571	634.9	1.9	46	wnw.	20.2
6:40 a. m....	721.1	9.2	38	wsw.	9.4	1,874	611.4	− 0.7	47	wnw.	19.8
6:51 a. m....	721.1	9.4	38	wsw.	10.3	2,288	580.3	− 3.2	44	wnw.	18.5
6:53 a. m....	721.1	9.4	38	wsw.	9.8	2,383	573.4	− 2.9	41	wnw.	15.9
6:55 a. m....	721.1	9.4	38	wsw.	9.8	2,508	564.5	− 3.7	38	wnw.	15.9
7:09 a. m....	721.1	9.7	37	wsw.	8.9	2,966	532.7	− 6.6	31	wnw.	21.5
7:25 a. m....	721.1	10.1	37	wsw.	8.9	3,757	480.7	−12.7	24	wnw.	25.8
7:48 a. m....	721.1	10.7	38	wsw.	8.0	4,196	453.7	−16.0	19	wnw.	28.0
8:02 a. m....	721.1	11.0	38	wsw.	8.0	4,446	....	....	17	wnw.	28.0
8:45 a. m....	721.0	12.1	36	wsw.	7.2	5,134	....	....	15	w.	29.3
9:44 a. m....	720.6	12.9	37	wsw.	9.8	4,146	....	−15.5	14	w.	26.7
10:09 a. m....	720.5	13.5	37	wsw.	8.9	3,477	....	−12.9	13	w.	26.5
10:25 a. m....	720.3	13.7	37	sw.	9.4	2,834	541.3	− 7.7	13	w.	18.9
10:40 a. m....	720.2	13.8	36	wsw.	10.7	2,225	584.8	− 2.1	13	wnw.	29.4
10:49 a. m....	720.2	14.2	37	wsw.	8.0	1,948	605.5	− 1.6	22	wnw.	21.1
10:52 a. m....	720.1	14.2	36	wsw.	8.0	1,914	607.9	− 2.0	29	wnw.	21.2
11:00 a. m....	720.1	14.7	37	wsw.	8.9	1,401	647.9	3.2	37	w.	17.2
11:12 a. m....	719.9	14.4	35	sw.	9.8	959	683.7	9.2	39	wsw.	14.2
11:18 a. m....	719.8	14.8	32	wsw.	8.0	526	719.8	14.8	32	wsw.	8.0
Apr. 25, 1912:											
6:18 a. m....	724.5	6.2	65	wnw.	5.8	526	724.5	6.2	65	wnw.	5.8
6:29 a. m....	724.7	6.2	65	wnw.	6.7	932	689.5	3.1	65	nnw.	15.7
6:42 a. m....	724.9	6.7	61	wnw.	6.7	1,492	643.2	− 3.0	65	nnw.	16.3
6:53 a. m....	725.0	6.8	62	wnw.	6.7	1,903	610.7	− 4.6	65	nnw.	25.5
7:01 a. m....	725.1	7.0	62	wnw.	6.7	2,244	585.2	− 0.9	44	nw.	25.7
7:11 a. m....	725.2	7.2	61	wnw.	7.2	2,849	542.4	− 4.4	34	nw.	25.3
7:38 a. m....	725.5	7.6	58	nw.	7.6	4,011	467.3	−12.3	25	nnw.	27.5
8:24 a. m....	725.9	8.4	54	wnw.	7.6	4,652	429.6	−19.3	21	nnw.	24.5
8:47 a. m....	726.1	8.7	50	wnw.	8.0	5,574	380.0	−24.6	20	nnw.	32.6
9:41 a. m....	726.5	9.6	47	wnw.	8.0	5,068	407.8	−20.6	20	nnw.	30.9
10:02 a. m....	726.6	10.1	47	wnw.	7.6	4,482	441.2	−17.5	20	nnw.	22.4
10:23 a. m....	726.7	10.7	48	n.	4.5	3,940	473.8	−11.5	23	nnw.	24.4
10:44 a. m....	726.8	11.2	48	nnw.	4.9	3,174	523.0	− 4.4	23	nnw.	19.2
10:58 a. m....	726.8	10.8	40	nnw.	6.7	2,180	592.6	0.0	20	nnw.	13.1
11:01 a. m....	726.8	10.8	40	nw.	7.6	1,707	628.8	− 2.2	19	nnw.	10.2
11:09 a. m....	726.8	11.8	44	nw.	4.0	526	726.8	11.8	44	nw.	4.0
Apr. 26, 1912:											
7:00 a. m....	727.6	7.4	74	sse.	13.4	526	727.6	7.4	74	sse.	13.4
7:08 a. m....	727.6	7.6	73	sse.	13.4	1,047	683.0	6.0	63	s.	23.5
7:14 a. m....	727.6	7.8	73	sse.	13.4	1,142	675.1	7.2	61	s.	23.5

April 24, 1912.—Seven kites were used; lifting surface, 44.1 sq. m. Wire out, 9,500 m.; at maximum altitude, 9,000 m.

The sky was cloudless until about 7 a. m., when a few Ci.-St. from the west appeared. After 9:45 a. m. there were also a few Cu. from the west-northwest.

High pressure (772 mm.) was central over Alabama. Low pressure (749 mm.) was central over the Gulf of St. Lawrence, with a secondary depression (758 mm.) north of Lake Huron.

April 25, 1912.—Six kites were used; lifting surface, 37.8 sq. m. Wire out, 10,000 m., at maximum altitude.

There were a few St.-Cu. from the north-northwest after 8 a. m.

High pressure (774 mm.) central over West Virginia, covered the eastern half of the United States.

April 26, 1912.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 6,000 m.; at maximum altitude, 5,100 m.

The sky was covered with A.-St. and St.-Cu. from the southwest, except from 8:37 to 9:08 a. m., when there were Nb. from the south, with light rain. The head kite entered clouds at 8:35 and emerged at 9:08 a. m.; altitude, approximately, 3,100 m.

High pressure (779 mm.) was central over Rhode Island and low pressure (743 mm.) was central over Minnesota.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
Apr. 26, 1912:	*mm.*	°*C.*	%		*m.p.s.*	*m.*	*mm.*	°*C.*	%		*m.p.s.*
7:28 a. m....	727.7	8.3	69	sse.	13.4	1,542	643.2	5.4	71	s.	25.2
7:30 a. m....	727.7	8.3	69	sse.	13.9	1,601	638.6	8.8	68	s.	25.2
7:35 a. m....	727.7	8.2	70	sse.	13.4	1,881	617.2	5.4	63	ssw.	23.5
7:54 a. m....	727.7	8.0	73	sse.	14.8	2,700	557.6	− 2.9	74	ssw.	25.5
8:08 a. m....	727.7	8.1	74	sse.	14.8	3,215	522.2	− 7.6	87	ssw.	26.8
8:16 a. m....	727.7	8.1	74	sse.	13.4	3,234	521.0	− 5.2	80	ssw.	25.5
8:50 a. m....	727.7	7.7	85	sse.	12.1	3,399	510.3	− 7.3	99	sw.	30.8
9:02 a. m....	727.7	7.6	87	sse.	12.1	3,129	528.3	− 5.6	95	sw.	27.8
9:24 a. m....	727.8	8.4	80	sse.	13.0	2,616	563.7	− 1.1	77	ssw.	25.5
9:49 a. m....	727.8	9.2	72	sse.	13.4	1,575	640.9	8.6	61	s.	15.3
10:01 a. m....	727.8	9.2	72	sse.	13.0	1,306	662.1	6.1	84	s.	23.2
10:15 a. m....	727.8	9.2	74	sse.	9.8	923	693.7	6.8	50	s.	24.5
10:28 a. m....	727.8	9.4	73	sse.	10.3	526	727.8	9.4	73	sse.	10.3
Apr. 27, 1912:											
6:34 a. m....	718.3	12.5	95	s.	5.8	526	718.3	12.5	95	s.	5.8
6:36 a. m....	718.3	12.6	94	s.	6.3	723	701.8	15.4	83	sw.	16.3
6:38 a. m....	718.3	12.7	94	s.	6.7	1,084	672.6	15.6	77	wsw.	22.9
6:58 a. m....	718.2	12.8	94	s.	7.6	1,595	633.0	10.5	75	wsw.	11.3
7:12 a. m....	718.2	13.4	90	s.	7.2	2,082	596.9	5.6	85	wsw.	13.5
7:36 a. m....	718.3	13.8	89	s.	6.3	2,637	557.7	4.0	61	wsw.	19.8
7:55 a. m....	718.4	14.0	88	ssw.	5.8	3,071	528.6	− 1.2	83	wsw.	16.3
8:19 a. m....	718.3	15.6	81	sw.	7.6	3,777	483.4	− 7.1	100	wsw.	18.3
8:47 a. m....	718.2	14.0	89	s.	4.9	3,986	469.2	− 9.0	91	wsw.	12.0
9:15 a. m....	718.2	14.0	90	sw.	5.4	3,205	517.6	− 4.0	95	w.	9.7
9:43 a. m....	718.2	13.9	92	wsw.	5.8	2,590	559.0	− 0.7	92	w.	8.7
10:07 a. m....	718.1	13.6	95	wsw.	7.2	1,819	615.0	4.9	86	wsw.	17.6
10:21 a. m....	717.9	14.1	90	wsw.	7.2	930	684.4	12.7	81	wsw.	19.0
10:27 a. m....	717.8	14.3	88	wsw.	7.2	526	717.8	14.3	88	wsw.	7.2
Apr. 28, 1912:											
6:22 a. m....	721.5	3.4	67	nw.	5.8	526	721.5	3.4	67	nw.	5.8
6:30 a. m....	721.6	3.4	68	nw.	4.9	815	696.3	0.3	72	nw.	8.7
6:48 a. m....	721.7	3.7	65	nw.	7.2	1,310	655.0	5.3	48	nnw.	12.3
7:10 a. m....	721.8	4.1	66	nw.	7.6	2,025	600.5	4.6	30	nnw.	11.7
8:41 a. m....	721.9	5.6	55	nw.	8.5	1,495	641.2	5.3	16	nnw.	9.2
8:52 a. m....	721.9	6.2	55	nw.	7.6	884	690.9	5.8	16	nw.	6.6
8:54 a. m....	721.9	6.2	55	nw.	7.6	728	704.3	3.2	21	nw.	3.8
9:10 a. m....	721.9	6.4	52	nw.	7.6	526	721.9	6.4	52	nw.	7.6
Apr. 29, 1912:											
6:12 a. m....	712.2	6.9	82	sse.	10.3	526	712.2	6.9	82	sse.	10.3
6:22 a. m....	712.2	7.0	82	sse.	10.7	1,161	660.2	15.1	67	sw.	23.5
6:30 a. m....	712.1	7.0	82	sse.	10.7	1,363	644.5	12.8	73	sw.	27.5
6:40 a. m....	712.1	7.0	82	sse.	10.7	1,789	612.8	12.8	63	sw.	24.4

April 27, 1912.—Seven kites were used; lifting surface, 44.1 sq. m. Wire out, 8,000 m.; at maximum altitude, 7,900 m.

The sky was covered with Ci.-St., A.-St. and St.-Cu., from the west-southwest. A solar halo was seen 6:30 to 7:20 a. m. Rain fell 8:58 to 10:32 a. m. The head kite entered St.-Cu. about 8:10 a. m.; altitude, 3,500 m.

Low pressure (755 mm.) was central over Quebec. High pressure was central over Minnesota (771 mm.) and over the Atlantic (772 mm.).

April 28, 1912.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 3,400 m.; at maximum altitude, 2,200 m.

There were 2/10 to few Ci. from the north-northwest.

High pressure (773 mm.) was central over Lake Ontario. Low pressure was central over Oklahoma (749 mm.) and over the Gulf of St. Lawrence (748 mm.).

April 29, 1912.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 6,000 m. at maximum altitude.

There were 10/10 St. from the southwest until 9:45 a. m., when dense fog began. The head kite entered St. clouds at 6:14 a. m., approximate altitude, 775 m. Light rain fell from 8:08 to 8:16 a. m., and from 8:55 to 8:57 a. m.

High pressure (765 mm.) was central over Vermont. Low pressure (751 mm.) was central over the lower Ohio Valley.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind. Direction.	Wind. Velocity.	Height.	Pressure.	Temperature.	Rel. hum.	Wind. Direction.	Wind. Velocity.
Apr. 29, 1912:	*mm.*	°*C.*	%		*m.p.s.*	*m.*	*mm.*	°*C.*	%		*m.p.s.*
6:46 a.m....	712.0	7.1	82	sse.	10.7	2,056	593.5	12.1	48	sw.	24.5
7:10 a.m....	711.9	7.2	83	sse.	10.7	2,442	566.6	7.6	64	sw.	24.5
7:21 a.m....	711.9	7.2	85	se.	10.7	2,951	532.4	3.6	52	sw.	25.8
7:40 a.m....	711.8	7.8	82	se.	10.7	3,817	477.6	− 4.8	66	sw.	25.5
8:12 a.m....	711.5	7.4	90	se.	11.2	3,468	498.7	− 1.4	100	sw.	27.5
8:22 a.m....	711.4	7.4	90	se.	11.6	2,649	551.9	4.4	98	sw.	22.4
8:36 a.m....	711.2	7.6	90	se.	11.6	1,880	605.5	11.5	79	ssw.	....
8:49 a.m....	711.1	7.9	91	se.	12.1	950	675.9	15.1	86	....	....
9:05 a.m....	710.8	7.8	91	se.	11.6	526	710.8	7.8	91	se.	11.6
Apr. 30, 1912:											
2:40 p.m....	712.6	4.5	100	nnw.	6.7	526	712.6	4.5	100	nnw.	6.7
3:04 p.m....	712.8	4.2	100	nnw.	8.0	1,004	671.9	1.1	100	nw.	14.7
3:07 p.m....	712.8	4.2	100	nnw.	8.0	1,258	651.2	3.8	100	wnw.	....
3:11 p.m....	712.8	4.2	100	nnw.	6.7	526	712.8	4.2	100	nnw.	6.7
May 1, 1912:											
1:20 p.m....	720.0	14.0	58	se.	5.8	526	720.0	14.0	58	se.	5.8
2:22 p.m....	719.3	14.8	58	se.	8.0	803	695.9	9.5	68	sse.	8.7
3:00 p.m....	718.9	15.2	53	sse.	8.5	1,074	673.2	7.0	74	sse.	12.0
4:32 p.m....	718.2	15.3	57	sse.	9.4	1,498	638.8	6.3	48	ssw.	7.6
4:34 p.m....	718.2	15.3	57	sse.	9.8	1,794	616.4	10.2	36	ssw.	8.4
4:40 p.m....	718.2	15.5	57	sse.	8.0	2,143	591.1	8.6	19	sw.	9.4
4:46 p.m....	718.2	15.4	57	sse.	8.0	2,605	559.2	5.5	13	sw.	14.5
4:54 p.m....	718.2	15.4	57	sse.	8.0	2,308	580.2	8.0	9	sw.	12.3
5:10 p.m....	718.1	15.2	57	sse.	8.5	1,690	624.8	12.4	4	ssw.	9.8
5:19 p.m....	718.0	15.0	57	s.	8.5	1,229	660.2	7.6	28	s.	13.8
5:30 p.m....	717.9	15.4	57	sse.	8.9	823	693.2	11.6	61	sse.	15.8
5:33 p.m....	717.9	15.2	57	sse.	9.8	526	717.9	15.2	57	sse.	9.8
May 2, 1912:											
6:24 a.m....	715.5	13.0	81	w.	9.4	526	715.5	13.0	81	w.	9.4
6:28 a.m....	715.5	13.1	80	w.	9.4	882	686.2	15.8	61	wnw.	8.3
6:51 a.m....	715.6	13.3	79	w.	9.4	1,616	629.2	11.5	63	nw.	23.5
7:11 a.m....	715.8	13.4	81	w.	7.6	1,910	607.6	10.8	67	nw.	23.5
7:30 a.m....	715.9	13.4	81	w.	7.6	2,786	546.7	5.7	65	wnw.	26.5
7:57 a.m....	716.0	14.0	80	w.	6.3	3,582	495.8	0.2	54	wnw.	26.5
8:22 a.m....	716.1	14.8	75	w.	5.4	4,295	453.3	− 6.6	71	wnw.	27.5
8:45 a.m....	716.3	16.2	72	w.	6.3	4,663	432.6	− 9.3	41	wnw.	28.6
9:12 a.m....	716.5	17.2	66	w.	8.0	4,699	430.4	−11.9	31	wnw.	28.6
10:30 a.m....	716.7	17.6	65	wnw.	5.4	3,587	495.8	0.2	41	wnw.	....
10:52 a.m....	716.6	18.2	65	wnw.	4.9	2,829	544.2	6.8	44	wnw.	....
10:54 a.m....	716.6	18.4	65	wnw.	4.9	2,719	551.5	5.5	53	wnw.	....
11:16 a.m....	716.6	19.0	63	wnw.	6.3	2,123	593.1	8.2	85	wnw.	24.5
11:24 a.m....	716.6	19.2	62	wnw.	4.9	1,538	636.1	12.3	88	wnw.	21.8
11:26 a.m....	716.6	19.2	62	wnw.	4.9	1,386	647.6	10.8	92	wnw.	21.8
11:39 a.m....	716.6	19.3	62	wnw.	4.9	526	716.6	19.3	62	wnw.	4.9

April 30, 1912.—Two kites were used; lifting surface, 14.6 sq. m. Wire out, 1,400 m., at maximum altitude.

There was dense fog.

Low pressure (756 mm.) was central over eastern Virginia and North Carolina, and high pressure (767 mm.) over Lake Superior.

May 1, 1912.—Six kites were used; lifting surface, 43.2 sq. m. Wire out, 4,800 m.; at maximum altitude, 3,000 m.

Ci.-St., from the west, increased from 2/10 to 5/10.

At 8 a. m., high pressure (768 mm.), central over Virginia, covered the United States east of the Mississippi.

May 2, 1912.—Six kites were used; lifting surface, 37.8 sq. m. Wire out, 8,500 m., at maximum altitude.

Ci.-St., from the west-northwest, increased from 3/10 at the beginning to 7/10 by 7:45 a. m., and disappeared by 11 a. m. After 10:20 a. m., there were a few Cu., from the west-northwest.

High pressure (767 mm.) was central over South Carolina. Pressure was low (761 mm.) over eastern New York.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
May 4, 1912:	*mm.*	°*C.*	%		*m.p.s.*	*m.*	*mm.*	°*C.*	%		*m.p.s.*
11:08 a. m....	718.2	15.6	49	e.	6.3	526	718.2	15.6	49	e.	6.3
11:41 a. m....	718.1	16.2	54	e.	6.7	832	692.5	11.1	48	e.	6.6
11:54 a. m....	718.1	16.0	49	e.	6.7	526	718.1	16.0	49	e.	6.7
May 5, 1912:											
6:13 a. m....	716.9	10.2	73	s.	7.6	526	716.9	10.2	73	s.	7.6
6:16 a. m....	716.9	10.2	73	s.	7.6	860	689.1	15.0	69	ssw.	13.8
6:32 a. m....	717.0	10.4	73	s.	8.5	1,430	644.0	9.5	72	sw.	14.8
6:45 a. m....	717.0	10.7	71	s.	8.0	1,724	621.6	9.3	75	sw.	10.2
8:34 a. m....	716.9	11.6	71	sse.	7.2	2,119	592.7	5.7	77	wsw.	17.5
8:43 a. m....	716.9	11.9	73	sse.	6.7	1,790	616.8	9.1	74	sw.	12.1
8:52 a. m....	716.8	12.0	71	sse.	7.6	1,412	645.2	11.9	73	sw.	13.3
9:07 a. m....	716.8	12.6	70	se.	8.5	874	687.8	14.2	63	s.	16.4
9:10 a. m....	716.8	12.6	70	se.	....	631	708.0	10.9	67	sse.	16.4
9:12 a. m....	716.8	12.6	70	se.	8.5	526	716.8	12.6	70	se.	8.5
May 6, 1912:											
3:19 p. m....	715.4	22.4	71	se.	6.7	526	715.4	22.4	71	se.	6.7
3:29 p. m....	715.4	22.4	73	se.	7.6	896	685.6	18.3	82	sse.	10.7
4:52 p. m....	714.9	21.6	78	se.	5.8	1,506	637.8	14.4	55	s.	8.0
5:12 p. m....	714.9	21.6	78	sse.	5.4	906	684.2	17.6	82	s.	....
5:18 p. m....	715.0	21.8	78	se.	4.9	526	715.0	21.8	78	se.	4.9
May 8, 1912:											
10:27 a. m....	707.4	12.4	100	nw.	7.2	526	707.4	12.4	100	nw.	7.2
10:42 a. m....	707.4	12.9	100	nw.	6.7	1,089	661.3	10.5	86	nnw.	24.1
10:45 a. m....	707.4	13.1	100	nw.	8.9	1,320	643.4	11.3	55	nnw.	24.1
11:00 a. m....	707.4	13.5	99	nw.	10.7	1,757	610.6	8.6	40	nnw.	23.5
11:15 a. m....	707.4	14.0	98	nw.	7.6	2,295	572.0	4.5	65	nnw.	20.4
11:45 a. m....	707.4	14.6	94	nw.	5.8	3,436	496.5	− 2.2	29	nnw.	15.3
12:30 p. m....	707.4	16.0	88	nw.	4.5	4,199	450.8	− 7.7	33	nw.	16.3
1:41 p. m....	707.2	16.9	84	n.	2.7	4,989	406.6	−14.4	61	nw.	19.0
2:20 p. m....	707.0	18.4	83	n.	2.2	3,677	482.2	− 5.4	31	nw.	21.6
2:47 p. m....	706.9	18.3	84	e.	2.2	2,624	549.9	1.6	77	nw.	22.7
3:05 p. m....	706.7	18.6	81	e.	2.7	1,230	650.8	14.3	82	nnw.	13.8
3:10 p. m....	706.7	19.0	78	e.	2.7	526	706.7	19.0	78	e.	2.7

May 4, 1912.—One kite was used; lifting surface, 11.2 sq. m. Wire out, 550 m., at maximum altitude.

There were 3/10 Ci.-St., from the west. A solar halo was visible.

Low pressure (750 mm.) was central over Kansas. High pressure (768 mm.) covered eastern Ontario and western Quebec.

May 5, 1912.—Seven kites were used; lifting surface, 441 sq. m. Wire out, 6,500 m.; at maximum altitude, 2,100 m.

Ci.-St., A.-Cu., and St.-Cu., from the west, decreased from 10/10 to 8/10.

High pressure (768 mm.) was central over New England. Low pressure (742 mm.) was central over North Dakota.

May 6, 1912.—Four kites were used; lifting surface, 30.1 sq. m. Wire out, 2,000 m.; at maximum altitude, 1,500 m.

There were 10/10 A.-Cu. and St.-Cu. from the west-southwest.

High pressure (770 mm.) was central over Nova Scotia, and low pressure (750 mm.) over North Dakota.

May 8, 1912.—Seven kites were used; lifting surface, 44.1 sq. m. Wire out, 9,000 m.; at maximum altitude, 8,550 m.

There was dense fog until 11 a. m.; thereafter there were from 2/10 to 8/10 Ci., A.-St., and A.-Cu. from the west-southwest, and St.-Cu. from the northwest. The head kite was in St.-Cu. momentarily at 2:48 p. m.; altitude, 2,550 m.

Low pressure (752 mm.) was central over Chesapeake Bay.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
May 9, 1912:	*mm.*	*°C.*	%		*m.p.s.*	*m.*	*mm.*	*°C.*	%		*m.p.s.*
6:20 a. m.....	707.7	12.4	70	wnw.	7.2	526	707.7	12.4	70	wnw.	7.2
6:30 a. m.....	707.7	12.4	70	wnw.	6.7	985	669.9	10.2	70	wnw.	18.9
6:43 a. m.....	707.7	12.6	71	wnw.	6.3	1,476	631.3	4.7	85	wnw.	20.4
7:02 a. m.....	707.7	13.4	66	nw.	7.6	2,296	570.3	− 1.6	68	w.	23.7
7:31 a. m.....	707.7	14.1	67	nw.	6.3	3,303	502.0	− 7.7	31	w.	29.4
7:44 a. m.....	707.7	14.4	63	wnw.	5.8	3,552	486.3	− 8.3	20	w.	28.6
7:57 a. m.....	707.7	14.4	65	wnw.	6.3	4,315	440.8	− 9.4	15	wnw.	35.4
8:15 a. m.....	707.7	14.7	66	wnw.	7.6	4,591	425.3	......	10	wnw.	41.0
10:28 a. m.....	707.4	16.5	45	wnw.	10.7	526	707.4	16.5	45	wnw.	10.7
May 10, 1912:											
6:16 a. m.....	713.6	10.0	59	wnw.	10.3	526	713.6	10.0	59	wnw.	10.3
6:25 a. m.....	713.6	10.0	59	wnw.	11.2	977	675.8	7.8	58	nw.	14.8
6:39 a. m.....	713.8	10.5	57	wnw.	12.5	1,630	624.4	2.9	64	nnw.	19.8
6:44 a. m.....	713.8	10.6	58	wnw.	12.5	2,032	594.3	6.1	39	nnw.	22.4
6:50 a. m.....	713.9	10.8	56	wnw.	12.5	2,237	579.8	4.4	27	nnw.	24.5
7:03 a. m.....	714.0	10.9	57	wnw.	11.2	3,045	524.8	2.1	15	nnw.	23.5
7:14 a. m.....	714.1	11.1	56	wnw.	11.2	3,656	486.4	− 2.1	8	nnw.	27.2
11:15 a. m.....	715.4	16.2	44	wnw.	10.7	526	715.4	16.2	44	wnw.	10.7
May 11, 1912:											
6:22 a. m.....	716.0	16.0	48	s.	8.9	526	716.0	16.0	48	s.	8.9
6:42 a. m.....	716.0	16.7	48	s.	8.5	1,389	646.8	12.7	50	ssw.	17.0
6:44 a. m.....	716.0	16.8	48	s.	8.9	1,486	639.4	13.2	46	ssw.	17.0
7:07 a. m.....	715.9	16.7	50	s.	5.8	1,861	611.4	9.3	41	ssw.	11.7
7:31 a. m.....	715.8	16.6	52	s.	6.3	1,989	601.8	7.8	41	ssw.	10.2
7:54 a. m.....	715.8	17.2	48	s.	8.9	2,327	577.7	4.3	41	ssw.	10.2
8:45 a. m.....	715.4	16.8	64	s.	7.2	3,001	531.2	1.5	28	ssw.	12.5
9:12 a. m.....	715.2	17.0	66	s.	8.9	3,571	494.8	− 0.8	18	ssw.	22.4
9:19 a. m.....	715.2	17.0	64	se.	8.9	4,196	457.6	− 5.0	16	sw.	21.0
9:43 a. m.....	715.2	17.2	64	se.	8.9	3,814	480.5	− 2.7	......	sw.	22.4
10:06 a. m.....	715.1	19.3	55	se.	10.7	3,163	521.5	2.0	......	ssw.	13.8
10:31 a. m.....	714.9	20.1	54	se.	12.5	2,645	555.7	4.3	......	ssw.	17.0
10:54 a. m.....	714.7	20.5	56	sse.	....	1,665	625.4	12.8	......	ssw.	20.0
10:56 a. m.....	714.7	20.5	56	sse.	13.9	1,632	627.8	11.9	......	ssw.	18.4
10:58 a. m.....	714.7	20.4	56	se.	13.4	1,602	630.0	13.3	......	s.	18.4
11:00 a. m.....	714.7	20.4	56	se.	13.9	1,572	632.3	11.6	......	s.	18.4
11:09 a. m.....	714.7	20.2	58	sse.	13.4	1,177	662.5	14.7	......	s.	23.5
11:24 a. m.....	714.6	20.4	59	sse.	12.5	526	714.6	20.4	59	sse.	12.5

May 9, 1912.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 7,500 m., at maximum altitude.

Cu. and St.-Cu., from the west-northwest, diminished from 4/10 at the beginning to few at 8 a. m., and increased to 6/10 by the end of the flight. The head kite was hidden by clouds at intervals from 6:58 to 9:54 a. m.; altitude of St.-Cu., 1,850 m.

Centers of low pressure (745 mm.) lay over southern Quebec, and over the Maine coast. Pressure was high (760 mm.) over the Mississippi Valley and the Gulf.

May 10, 1912.—Seven kites were used; lifting surface, 44.1 sq. m. Wire out, 11,000 m.; at maximum altitude, 4,700 m.

The sky was cloudless.

High pressure (763 mm.) was central over West Virginia. Low pressure (751 mm.) was central over New Brunswick.

May 11, 1912.—Seven kites were used; lifting surface, 44.1 sq. m. Wire out, 8,000 m.; at maximum altitude, 7,400 m.

Ci. and Ci.-St., from the southwest, increased from 3/10 to 9/10. A solar halo was visible after 9 a. m.

High pressure (765 mm.) was central over the Atlantic. Low pressure (746 mm.) was central over Missouri.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
May 12, 1912:	*mm.*	°*C.*	%		*m. p. s.*	*m.*	*mm.*	°*C.*	%		*m. p. s.*
10:48 a. m.	711.2	15.2	100	se.	12.5	526	711.2	15.2	100	se.	12.5
10:59 a. m.	711.2	15.2	100	se.	13.4	998	672.4	11.5	96	s.	20.4
11:19 a. m.	711.2	15.4	100	se.	13.9	1,617	584.6	11.1	66	ssw.	26.5
11:31 a. m.	711.2	15.5	100	se.	16.5	2,173	584.1	5.8	70	ssw.	23.9
11:55 a. m.	711.0	15.7	100	se.	16.1	2,919	532.9	0.3	68	ssw.	22.1
12:16 p. m.	710.7	16.6	95	se.	9.8	2,109	589.0	7.9	63	ssw.	18.9
12:30 p. m.	710.4	16.4	97	se.	11.6	1,644	622.3	12.8	69	ssw.	22.0
12:31 p. m.	710.4	16.4	97	se.	11.6	1,582	627.0	10.7	85	ssw.	22.0
12:42 p. m.	710.3	16.4	97	se.	11.6	1,329	646.0	12.7	99	ssw.	20.4
12:51 p. m.	710.3	16.6	98	se.	11.6	526	710.3	16.6	98	se.	11.6
May 13, 1912:											
8:20 a. m.	711.8	13.0	81	wnw.	9.8	526	711.8	13.0	81	wnw.	9.8
8:30 a. m.	711.8	12.6	79	wnw.	10.3	864	683.5	7.2	73	wnw.	17.3
8:45 a. m.	711.8	12.5	74	w.	10.3	1,404	639.9	5.0	76	w.	14.9
9:00 a. m.	711.9	12.8	76	nw.	13.9	1,676	619.0	2.1	82	wsw.	12.4
9:22 a. m.	712.1	12.8	71	wnw.	13.9	1,965	597.4	0.0	93	sw.	13.3
9:26 a. m.	712.2	12.7	85	nw.	14.3	2,195	580.5	− 1.4	93	sw.	27.5
9:31 a. m.	712.2	12.8	71	nw.	14.3	2,739	542.4	2.1	35	w.	30.6
9:41 a. m.	712.3	13.2	69	wnw.	15.6	3,309	504.9	− 2.2	12	w.	30.6
10:12 a. m.	712.7	12.8	60	w.	18.8	2,643	548.6	0.1	9	w.	....
10:27 a. m.	712.9	12.8	56	w.	17.9	2,486	559.6	− 3.5	19	w.	....
10:39 a. m.	713.1	12.8	55	wnw.	17.4	1,715	616.6	0.2	85	wsw.	....
10:53 a. m.	713.3	12.0	66	wnw.	12.1	1,389	642.2	2.1	85	w.	....
11:09 a. m.	713.5	11.8	62	wnw.	12.1	851	686.2	7.0	78	wnw.	....
11:15 a. m.	713.6	11.8	62	wnw.	12.1	526	713.6	11.8	62	wnw.	12.1
May 14, 1912:											
First flight—											
6:42 a. m.	719.4	9.2	60	w.	8.9	526	719.4	9.2	60	w.	8.9
6:51 a. m.	719.5	9.6	62	w.	8.9	1,003	679.3	7.5	54	w.	10.9
7:03 a. m.	719.5	10.1	55	w.	7.2	1,122	669.6	8.2	23	wnw.	9.2
7:42 a. m.	719.5	11.1	58	w.	4.9	1,433	644.9	6.7	15	wnw.	8.8
7:54 a. m.	719.6	11.3	59	w.	4.9	1,219	661.9	7.4	15	w.	8.5
8:07 a. m.	719.6	11.8	53	w.	3.6	840	693.1	8.2	41	w.	6.8
8:15 a. m.	719.6	12.0	......	w.	3.6	526	719.6	12.0	......	w.	3.6

May 12, 1912.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 4,000 m.; at maximum altitude, 3,500 m.

There were 10/10 St., from the southeast. The head kite entered St. at 10:51 a. m., approximate altitude 625 m.

High pressure (772 mm.) was central over the Atlantic Ocean. Low pressure (750 mm.) was central over Indiana.

May 13, 1912.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 4,500 m., at maximum altitude.

St.-Cu., from the southwest, varied from 9/10 to 6/10. Before 9:10 a. m. there were from 1/10 to 2/10 St.-Cu., from the west.

Low pressure (753 mm.) was central over the upper St. Lawrence. High pressure (778 mm.) was central over Montana.

May 14, 1912.—*First flight:* Three kites were used; lifting surface, 20.9 sq. m. Wire out 1,900 m., at maximum altitude.

There were 9/10 A.-Cu., from the west-southwest, followed by 6/10 Ci.-St., from the west-southwest, with a solar halo.

Second flight. Five kites were used; lifting surface, 33.5 sq. m. Wire out, 4,700 m., at maximum altitude.

There were 10/10 A.-St., from the southwest. The head kite was in A.-St. momentarily at 3:20 p. m.; approximate altitude, 2,600 m.

High pressure (767 mm.) was central over Virginia. Low pressure (748 mm.) was central over the lower St. Lawrence Valley.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
May 14, 1912:											
Second flight—	mm.	°C.	%		m. p. s.	m.	mm.	°C.	%		m. p. s.
1:23 p. m....	718.7	13.4	53	s.	5.4	526	718.7	13.4	53	s.	5.4
1:33 p. m....	718.6	13.6	50	s.	6.3	994	679.6	9.4	56	s.	11.9
1:45 p. m....	718.5	13.8	51	s.	5.4	1,352	650.8	7.5	50	ssw.	8.8
2:07 p. m....	718.3	14.0	55	s.	6.3	1,802	615.7	2.5	56	ssw.	10.6
2:35 p. m....	718.0	13.4	57	s.	5.8	2,112	592.2	− 0.3	62	sw.	11.9
3:04 p. m....	717.6	13.6	56	s.	4.9	2,334	575.8	− 2.0	56	sw.	10.2
3:10 p. m....	717.6	13.6	56	s.	4.5	2,810	541.7	− 4.3	84	sw.	23.1
3:30 p. m....	717.3	13.8	56	s.	4.0	2,416	568.5	− 3.9	95	sw.	15.0
3:44 p. m....	717.2	13.6	56	s.	3.1	1,899	606.6	− 0.4	62	sw.	13.6
3:52 p. m....	717.2	13.4	57	s.	4.5	1,426	643.3	3.3	62	sw.	11.6
4:00 p. m....	717.1	13.5	56	s.	4.5	951	681.6	8.3	57	ssw.	11.9
4:11 p. m....	717.1	13.6	57	s.	3.1	526	717.1	13.6	57	s.	3.1
May 15, 1912:											
12:48 p. m....	714.7	11.2	81	se.	8.5	526	714.7	11.2	81	se.	8.5
12:59 p. m....	714.6	11.1	85	se.	9.8	872	685.6	8.4	90	se.	11.0
1:07 p. m.....	714.6	11.1	86	se.	9.4	1,343	647.2	4.7	96	se.	8.8
1:18 p. m.....	714.7	11.1	86	se.	7.2	991	675.7	6.2	94	se.	7.5
1:31 p. m.....	714.8	10.8	90	sse.	4.5	526	714.8	10.8	90	sse.	4.5
May 16, 1912:											
5:30 p. m.....	705.1	16.5	81	sse.	6.7	526	705.1	16.5	81	sse.	6.7
5:41 p. m.....	705.1	16.2	82	sse.	6.3	919	672.9	11.4	89	sse.	11.7
5:50 p. m.....	705.1	16.2	82	sse.	7.6	1,039	663.5	12.0	75	s.	10.2
5:55 p. m.....	705.1	16.2	83	sse.	7.6	1,430	633.1	8.8	75	s.	12.3
6:08 p. m.....	705.1	16.2	83	sse.	7.2	2,050	587.1	3.4	73	ssw.	13.5
6:28 p. m.....	705.2	16.2	86	se.	7.2	2,967	523.6	− 4.8	78	sw.	21.2
6:50 p. m....	705.3	15.3	90	se.	7.6	2,102	583.4	2.2	81	ssw.	17.2
7:01 p. m.....	705.3	15.2	90	se.	7.6	1,476	629.7	8.3	82	s.	17.4
7:13 p. m.....	705.4	14.8	93	se.	7.6	940	671.5	11.6	93	sse.	9.5
7:19 p. m.....	705.5	14.6	94	se.	7.2	526	705.5	14.6	94	se.	7.2
May 17, 1912:											
6:48 a. m.....	708.7	9.8	57	wsw.	7.2	526	708.7	9.8	57	wsw.	7.2
7:00 a. m.....	708.8	9.6	59	wsw.	8.0	1,023	667.4	6.2	59	wsw.	13.9
7:17 a. m.....	708.9	10.1	44	wsw.	7.6	1,622	620.3	2.0	64	w.	15.8
7:36 a. m.....	709.1	10.4	56	wsw.	7.6	2,282	571.2	− 3.8	76	w.	15.8
7:56 a. m.....	709.4	10.9	56	wsw.	7.6	3,023	520.2	− 6.6	56	w.	17.8
8:14 a. m.....	709.5	11.0	58	wsw.	7.2	3,585	484.1	−10.1	44	w.	19.8

May 15, 1912.—Two kites were used; lifting surface, 12.6 sq. m. Wire out, 1,200 m., at maximum altitude.

The sky was covered with St.-Cu. from the southeast. Rain fell after 1:10 p. m. The head kite entered St.-Cu. at 1:02 p. m., altitude 940 m., and fell below St.-Cu. about 1:28 p. m.

Low pressure was central over Wisconsin (753 mm.) and over Georgia (757 mm.). Pressure was high over the Atlantic.

May 16, 1912.—Four kites were used; lifting surface, 30.1 sq. m. Wire out, 3,400 m.; at maximum altitude, 3,100 m.

There were 7/10 Cu. and St.-Cu., from the south, until 7 p. m. Thereafter there were 6/10 St.- Cu. and Cu.-N., from the south. The head kite was in St.-Cu., altitude 950 m., at 5:52 p. m.

At 8 a. m. low pressure, central over Ohio (751 mm.) and over Virginia (752 mm.), covered the eastern part of the United States, except New England.

May 17, 1912.—Seven kites were used; lifting surface, 44.1 sq. m. Wire out, 10,000 m., at maximum altitude.

There were a few A.-Cu., from the west-southwest, at the beginning of the flight. St.-Cu., from the west, increased from 6/10 to 10/10 between 9 and 11 a. m. Light rain fell 11:15 to 11:34 a. m. and 12:02 to 12:07 p. m. The head kite was in St.-Cu. momentarily at 12:18 p. m., altitude 1,800 m.

High pressure (767 mm.) was central over the lower Mississippi Valley. Low pressure (751 mm.) was central over the upper St. Lawrence Valley.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind. Direction.	Wind. Velocity.	Height.	Pressure.	Temperature.	Rel. hum.	Wind. Direction.	Wind. Velocity.
May 17, 1912:	*mm.*	°*C.*	%		*m.p.s.*	*m.*	*mm.*	°*C.*	%		*m.p.s.*
9:06 a. m....	709.7	11.6	57	wsw.	8.0	4,793	412.8	−20.2	70	w.	26.4
10:10 a. m....	710.4	12.0	60	ssw.	8.0	5,228	389.1	....	44	w.	26.4
11:00 a. m....	710.9	12.0	59	wsw.	8.0	4,597	423.7	....	43	wsw.	26.4
11:40 a. m....	711.2	12.6	61	w.	8.5	3,551	486.8	− 9.2	45	w.	19.8
12:07 p. m....	711.4	12.3	63	w.	8.9	2,400	564.1	− 6.0	91	w.	21.1
12:29 p. m....	711.6	13.6	60	w.	8.9	2,133	584.1	− 4.1	88	w.	19.8
12:45 p. m....	711.6	13.9	56	wsw.	8.9	1,440	637.0	1.8	80	wsw.	13.2
12:52 p. m....	711.6	13.2	55	w.	8.9	950	676.3	7.9	66	w.	11.9
1:02 p. m....	711.6	12.8	55	w.	8.9	526	711.6	12.8	55	w.	8.9
May 18, 1912:											
6:10 a. m....	720.3	10.0	64	wnw.	8.9	526	720.3	10.0	64	wnw.	8.9
6:20 a. m....	720.3	10.0	66	wnw.	9.4	911	687.6	8.5	59	wnw.	15.8
6:31 a. m....	720.4	10.0	66	wnw.	8.9	1,325	654.0	6.3	49	nw.	11.2
6:43 a. m....	720.4	10.4	64	wnw.	9.4	1,693	625.3	4.4	35	nw.	8.6
7:53 a. m....	720.8	11.7	63	wnw.	9.8	1,890	610.7	2.0	37	nw.	5.6
8:05 a. m....	720.8	12.0	59	wnw.	8.9	2,842	542.2	− 3.3	41	nw.	6.2
8:15 a. m....	720.9	12.4	58	wnw.	8.9	2,584	560.0	− 0.3	39	nw.	6.4
8:26 a. m....	721.0	12.8	59	wnw.	8.9	2,194	588.1	1.9	25	nw.	11.2
8:39 a. m....	721.0	12.8	55	wnw.	9.8	1,771	619.8	0.8	18	nw.	9.9
8:59 a. m....	721.2	13.3	53	wnw.	9.4	1,349	653.0	5.2	29	nw.	11.6
9:12 a. m....	721.3	13.8	51	wnw.	8.9	878	691.6	8.6	54	nw.	11.2
9:18 a. m....	721.4	12.6	62	wnw.	8.0	526	721.4	12.6	62	wnw.	8.0
May 19, 1912:											
6:09 a. m....	720.7	14.7	54	wnw.	12.1	526	720.7	14.7	54	wnw.	12.1
6:17 a. m....	720.6	14.5	54	wnw.	13.4	926	687.4	13.4	53	wnw.	16.2
6:34 a. m....	720.5	14.6	54	wnw.	10.7	1,501	642.0	13.0	59	nw.	10.2
6:45 a. m....	720.5	14.7	55	wnw.	10.3	1,919	610.8	9.2	63	wnw.	9.2
7:00 a. m....	720.4	15.1	54	wnw.	10.7	2,581	563.4	5.3	58	wnw.	11.9
7:17 a. m....	720.3	15.9	52	wnw.	13.4	3,533	500.8	− 3.3	69	w.	15.8
7:27 a. m....	720.3	15.8	53	wnw.	8.9	4,081	466.8	− 8.4	75	w.	23.7
7:53 a. m....	720.1	16.3	53	w.	9.8	4,879	420.9	−15.1	91	w.	25.2
8:16 a. m....	720.0	17.0	52	w.	8.9	4,779	420.6	−13.4	49	w.	21.1
8:38 a. m....	719.8	17.3	51	w.	8.9	4,199	459.1	− 9.5	86	w.	20.0
9:01 a, m....	719.6	17.5	50	w.	8.9	3,479	503.4	− 2.5	73	wnw.	18.1
9:25 a. m....	719.4	18.0	51	w.	7.6	2,434	572.6	7.2	58	wnw.	18.7
9:26 a. m....	719.4	18.1	50	w.	7.6	2,340	579.2	6.6	57	wnw.	18.7
9:44 a. m....	719.2	18.8	51	w.	8.0	1,633	630.7	9.6	67	wnw.	18.7
9:46 a. m....	719.2	18.8	51	w.	8.0	1,499	640.9	9.0	73	wnw.	14.5
10:02 a. m....	719.1	18.8	51	w.	8.0	817	695.1	14.7	57	w.	8.9
10:06 a. m....	719.0	18.8	51	w.	8.0	526	719.0	18.8	51	w.	8.0
May 20, 1912:											
12:40 p. m....	721.3	25.1	45	se.	6.7	526	721.3	25.1	45	se.	6.7
1:05 p. m....	721.1	25.8	49	s.	5.8	900	690.9	19.6	50	s.	7.6
2:22 p. m....	720.4	26.4	47	se.	5.8	1,278	660.6	16.1	56	s.	11.2
3:10 p. m....	720.0	26.2	46	s.	6.7	1,504	642.8	14.5	56	s.	9.2
3:55 p. m....	719.7	26.6	47	s.	6.3	2,130	596.3	7.6	67	ssw.	11.9
4:50 p. m....	719.4	26.3	46	s.	4.9	2,522	568.2	3.3	74	sw.	12.9

May 18, 1912.—Seven kites were used; lifting surface, 44.1 sq. m. Wire out, 6,700 m.; at maximum altitude, 5,000 m.

Ci.-St., from the west, increased from 2/10 to 10/10.

High pressure (772 mm.) was central over eastern Tennessee. Low pressure was central over Nova Scotia (753 mm.) and over Lake Superior (755 mm.).

May 19, 1912.—Seven kites were used; lifting surface, 44.1 sq. m. Wire out, 8,500 m.; at maximum altitude, 8,200 m.

Ci. and A.-Cu., from the west-northwest, diminished from 8/10 to few.

High pressure (771 mm.) was central over eastern Tennessee and North Carolina, and low pressure (754 mm.) over Nova Scotia.

May 20, 1912.—Seven kites were used; lifting surface, 46.1 sq. m. Wire out, 6,500 m.; at maximum altitude, 5,600 m.

There were 2/10 Cu. and Cu.-N., from the west. After 5:40 p. m. there were also a few A.-Cu., from the same direction. Thunder was heard at 4:25 p. m.

At 8 a. m. high pressure (770 mm.) covered the Atlantic coast. Low pressure (755 mm.) was central over Kansas.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
May 20, 1912:	mm.	°C.	%		m. p. s.	m.	mm.	°C.	%		m. p. s.
5:05 p. m....	719.4	26.2	47	s.	4.9	2,894	542.6	0.9	62	sw.	15.5
5:21 p. m....	719.3	25.7	49	s.	5.4	3,849	481.5	−6.4	34	wsw.	18.7
5:32 p. m....	719.3	25.9	49	s.	5.8	3,401	509.8	−4.1	44	wsw.	23.8
5:45 p. m....	719.2	25.9	48	s.	5.8	2,670	558.4	3.6	60	wsw.	18.1
5:53 p. m....	719.2	25.6	49	s.	6.3	2,179	592.7	8.5	63	sw.	....
6:01 p. m....	719.2	25.6	49	se.	5.4	1,684	628.8	13.1	54	sw.	9.9
6:08 p. m....	719.2	25.1	49	s.	5.8	1,361	653.2	16.6	52	ssw.	13.8
6:21 p. m....	719.2	25.0	48	s.	6.3	929	686.8	21.2	50	s.	14.8
6:25 p. m....	719.2	24.7	49	s.	6.3	526	719.2	24.7	49	s.	6.3
May 21, 1912:											
6:12 a. m....	719.9	19.0	57	w.	9.4	526	719.9	19.0	57	w.	9.4
6:16 a. m....	720.0	18.8	58	w.	8.9	796	697.8	21.0	46	wnw.	12.8
6:38 a. m....	720.0	18.6	60	w.	8.5	1,420	648.8	15.5	43	wnw.	15.3
6:47 a. m....	720.0	18.6	64	w.	8.5	1,795	620.8	11.7	41	wnw.	21.9
7:25 a. m....	720.0	18.6	61	w.	7.2	914	688.3	18.8	43	wnw.	15.3
7:46 a. m....	720.1	19.8	56	w.	5.8	1,573	637.3	13.4	43	wnw.	18.4
7:55 a. m....	720.1	20.2	63	w.	5.4	1,989	606.3	9.6	36	wnw.	14.3
8:43 a. m....	720.2	21.2	54	w.	4.5	2,297	584.5	7.5	14	w.	9.2
9:23 a. m....	720.0	22.4	54	w.	5.4	2,843	546.5	3.4	16	w.	11.1
9:41 a. m....	720.0	22.6	51	wnw.	5.8	2,022	603.9	8.4	20	w.	13.5
9:53 a. m....	719.9	22.8	52	wnw.	6.7	1,419	648.8	14.6	29	wnw.	12.8
10:06 a. m....	719.9	22.8	54	wnw.	6.7	865	692.4	19.0	40	wnw.	10.7
10:12 a. m....	719.9	23.4	47	wnw.	8.5	526	719.9	23.4	47	wnw.	8.5
May 22, 1912:											
1:11 p. m....	719.3	24.8	63	ese.	6.7	526	719.3	24.8	63	ese.	6.7
5:06 p. m....	718.3	24.0	55	sse.	8.9	1,733	624.0	12.8	37	sse.	4.5
5:17 p. m....	718.3	23.7	55	sse.	8.9	1,561	636.8	12.7	55	sse.	12.8
5:28 p. m....	718.3	23.5	54	sse.	7.6	1,215	663.3	16.4	53	sse.	11.4
5:38 p. m....	718.3	23.2	55	sse.	8.9	895	688.5	19.2	54	sse.	11.7
5:44 p. m....	718.3	23.4	58	sse.	6.7	526	718.3	23.4	58	sse.	6.7
May 23, 1912:											
10:02 a. m....	720.5	14.5	100	sse.	7.2	526	720.5	14.5	100	sse.	7.2
10:09 a. m....	720.5	14.8	100	sse.	8.5	687	707.0	12.9	99	s.	14.8
10:28 a. m....	720.5	15.1	100	sse.	6.3	1,081	674.8	15.8	74	s.	8.7
12:37 p. m....	719.8	18.4	90	se.	8.0	1,352	653.1	12.4	83	s.	6.6
1:41 p. m....	719.5	19.5	87	se.	8.0	825	694.9	15.6	86	sse.	11.1
1:48 p. m....	719.5	18.9	86	se.	8.5	526	719.5	18.9	86	se.	8.5

May 21, 1912.—Five kites were used; lifting surface, 32 sq. m. Wire out, 4,630 m.; at maximum altitude, 3,700 m.

The sky was cloudless.

High pressure (770 mm.) was central over the Carolina coast. Low pressure (762 mm.) was central over southern Michigan.

May 22, 1912.—Seven kites were used; lifting surface, 47.1 sq. m. Wire out, 5,000 m.; at maximum altitude, 2,450 m.

There were a few to 2/10 Cu. from the east-southeast, southeast, and south-southeast during the flight, and 2/10 Ci.-St. near the horizon after 4:10 p. m.

High pressure (771 mm.) was central over northern Maine. Low pressure (750 mm.) was central over Iowa.

May 23, 1912.—Seven kites were used; lifting surface, 44.1 sq. m. Wire out, 4,900 m.; at maximum altitude, 4,800 m.

There was dense fog until 11:15 a. m. Thereafter there were from 10/10 to 9/10 St. from the south-southeast. The head kite emerged from St., altitude 800 m., at 1:37 p. m.

Pressure was high (772 mm.) east of the North Atlantic coast. Low pressure was central over Iowa (753 mm.) and over the North Carolina coast (761 mm.).

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind. Direction.	Wind. Velocity.	Height.	Pressure.	Temperature.	Rel. hum.	Wind. Direction.	Wind. Velocity.
May 24, 1912:	*mm.*	°*C.*	%		*m. p. s.*	*m.*	*mm.*	°*C.*	%		*m. p. s.*
1:19 p. m...	714.3	27.8	48	wsw.	7.2	526	714.3	27.8	48	wsw.	7.2
1:53 p. m...	713.7	28.1	44	w.	6.7	1,215	659.8	19.7	50	w.	9.2
2:14 p. m...	713.6	27.6	42	w.	8.9	1,847	612.6	12.0	59	w.	13.3
2:29 p. m...	713.6	26.6	48	w.	8.0	2,317	578.9	8.6	49	wnw.	14.3
2:56 p. m...	713.5	27.1	41	w.	10.7	2,856	542.2	4.6	32	w.	17.3
2:58 p. m...	713.5	27.0	41	w.	10.7	2,933	537.2	6.1	29	w.	19.4
3:03 p. m...	713.5	27.6	39	w.	9.4	3,463	503.3	− 0.2	27	w.	20.4
3:27 p. m...	713.4	27.8	40	w.	8.9	3,776	484.0	− 2.7	22	w.	20.4
3:43 p. m...	713.4	27.0	41	w.	9.8	4,941	416.4	−13.4	48	w.	23.5
4:05 p. m...	713.4	27.0	43	w.	9.8	5,291	397.7	−16.9	84	w.	23.5
4:31 p. m...	713.4	26.8	45	w.	9.4	4,701	429.0	−12.0	68	w.	24.5
4:50 p. m...	713.3	26.6	46	w.	8.0	3,950	472.4	− 4.6	52	w.	23.5
5:06 p. m...	713.3	26.9	45	w.	8.0	3,375	508.1	0	63	wnw.	20.4
5:21 p. m...	713.2	26.8	45	w.	8.0	2,326	577.7	7.2	76	w.	20.4
5:32 p. m...	713.2	26.9	43	w.	8.0	1,838	612.6	12.0	70	w.	20.4
5:44 p. m...	713.2	26.6	46	wnw.	8.0	1,361	648.0	17.2	60	w.	15.3
6:07 p. m...	713.2	26.1	49	wnw.	6.3	526	713.2	26.1	49	wnw.	6.3
May 25, 1912:											
6:19 a. m....	716.6	15.8	59	nw.	11.2	526	716.6	15.8	59	nw.	11.2
6:26 a. m....	716.6	15.9	60	nw.	10.3	984	678.9	11.8	66	nw.	16.8
6:39 a. m....	716.6	16.0	53	nw.	9.8	1,306	653.5	15.9	40	nw.	21.8
6:52 a. m....	716.7	15.2	59	nw.	7.6	1,776	618.3	13.3	25	nw.	18.1
7:03 a. m....	716.7	15.0	60	nw.	7.2	2,249	584.5	8.7	31	nw.	19.4
7:19 a. m....	716.7	15.4	70	nw.	7.2	2,801	546.4	3.8	34	wnw.	19.9
7:58 a. m....	716.8	16.5	62	nw.	12.5	3,935	474.1	− 6.8	90	wnw.	24.5
9:10 a. m....	717.5	17.2	69	nw.	9.8	4,796	424.6	−12.0	61	wnw.	....
9:24 a. m....	717.5	17.5	64	nw.	10.3	3,163	523.3	− 0.3	72	wnw.	....
10:58 a. m....	717.6	18.6	62	nw.	12.1	3,164	523.3	− 0.5	57	wnw.	....
11:11 a. m....	717.6	18.6	60	nw.	12.5	3,838	480.7	− 5.9	95	wnw.	....
11:31 a. m....	717.6	18.9	56	nw.	11.6	4,559	438.3	− 9.6	66	wnw.	29.1
12:07 p. m....	717.6	18.9	57	nw.	10.3	3,830	479.6	− 6.3	96	wnw.	23.5
12:36 p. m....	717.5	19.2	57	nw.	12.1	2,776	547.7	2.3	54	wnw.	18.4
1:43 p. m...	717.4	19.2	59	nw.	8.9	2,243	584.5	7.3	38	wnw.	19.4
2:20 p. m...	717.4	18.3	64	nw.	8.0	1,793	617.1	10.2	43	wnw.	16.3
3:28 p. m...	717.3	17.5	67	nw.	5.8	1,791	617.1	9.1	42	wnw.	19.4
4:32 p. m...	717.2	17.8	66	nw.	6.3	1,790	617.1	8.2	59	wnw.	....
5:21 p. m...	717.2	18.1	64	nw.	5.8	1,789	617.1	6.9	66	wnw.	....
5:41 p. m...	717.2	18.1	64	nw.	7.2	1,583	632.7	9.1	54	wnw.	....
5:43 p. m...	717.2	18.1	64	nw.	7.2	1,477	640.8	8.9	53	wnw.	....
5:53 p. m...	717.2	18.3	64	nw.	6.7	1,009	677.6	13.0	70	wnw.	....
6:00 p. m...	717.2	18.1	64	nw.	6.7	532	716.6	18.5	68	nw.	....

May 24, 1912.—Eight kites were used; lifting surface, 52.4 sq. m. Wire out, 8,000 m. at maximum altitude.

There were 8/10 to 4/10 Ci. from the west-northwest and A.-Cu. from the west until 5 p. m.; thereafter there were 3/10 Ci. from the west-northwest. The head kite was in A.-Cu. from 3:55 to 4:13 p. m.; altitude, 5,100 m.

High pressure (766 mm.) was central over Alabama. Low pressure (751 mm.) was central over the lower St. Lawrence Valley.

May 25, 1912.—Nine kites were used; lifting surface, 56.7 sq. m. Wire out, 10,000 m.; at maximum altitude, 9,800 m.

The sky was covered with Ci.-St. and A.-Cu. from the west. A solar halo was visible at times. No cloud notes were taken after 9:10 a. m. The kites, after breaking away, flew from points in Loudoun Valley, 5 to 15 kilometers east-southeast of the station.

At 8 a. m. high pressure (768 mm.) was central over eastern Iowa and low pressure (749 mm.) over the Gulf of St. Lawrence.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
May 26, 1912:	*mm.*	*°C.*	*%*		*m. p. s.*	*m.*	*mm.*	*°C.*	*%*		*m. p. s.*
6:41 a. m....	719.8	12.2	76	nw.	5.8	526	719.8	12.2	76	nw.	5.8
6:57 a. m....	719.9	12.2	78	nnw.	4.5	953	684.2	10.9	66	nnw.	8.2
7:48 a. m....	720.0	13.7	68	nw.	4.9	1,364	651.3	8.4	70	nw.	7.8
8:15 a. m....	720.1	14.1	67	nw.	5.8	1,695	625.8	6.3	45	nw.	10.6
9:07 a. m....	720.1	15.2	67	nw.	8.0	2,115	594.6	3.8	33	nw.	6.9
9:37 a. m....	720.0	15.2	71	nnw.	7.2	2,492	567.3	− 0.3	33	nnw.	8.8
9:44 a. m....	720.0	15.8	61	nnw.	7.2	2,920	537.5	− 3.1	36	nnw.	8.6
9:49 a. m....	720.0	16.0	60	nnw.	6.7	2,373	575.8	0.7	35	nnw.	7.6
10:02 a. m....	720.0	16.5	56	nnw.	7.6	1,758	620.9	6.5	24	nnw.	6.9
10:23 a. m....	719.9	16.9	53	nw.	7.6	1,272	658.6	6.8	65	nw.	11.2
10:40 a. m....	719.9	16.9	51	nw.	8.9	1,010	679.8	10.0	65	nw.	11.6
10:57 a. m....	719.8	17.2	51	nw.	8.0	526	720.0	17.2	51	nw.	8.0
May 27, 1912:											
10:04 a. m....	719.2	19.2	50	sse.	7.6	526	719.2	19.2	50	sse.	7.6
10:24 a. m....	719.0	20.0	50	sse.	8.0	996	680.6	14.5	49	s.	8.9
10:36 a. m....	719.0	19.8	42	sse.	8.5	1,319	655.2	14.3	41	s.	7.6
11:00 a. m....	718.8	20.4	46	sse.	8.5	1,745	622.7	9.8	54	s.	7.6
11:26 a. m....	718.5	21.4	43	sse.	8.9	2,218	587.9	6.9	60	sw.	9.2
11:57 a. m....	718.0	20.8	45	sse.	8.9	2,515	566.6	3.8	62	sw.	8.2
1:04 p. m....	717.3	21.8	42	sse.	8.9	3,276	515.6	2.2	26	sw.	8.0
1:16 p. m....	717.1	21.8	41	sse.	8.9	2,558	562.9	5.8	18	sw.	9.2
1:30 p. m....	717.0	21.7	39	sse.	9.8	2,140	592.2	8.0	49	s.	10.5
1:42 p. m....	717.0	21.8	43	sse.	8.0	1,508	638.9	10.8	62	s.	13.2
1:56 p. m....	716.9	22.0	45	sse.	8.0	968	681.1	15.8	51	s.	10.2
2:05 p. m....	716.9	21.8	45	sse.	7.2	526	716.9	21.8	45	sse.	7.2
May 28, 1912:											
6:54 a. m....	712.9	15.4	76	s.	5.8	526	712.9	15.4	76	s.	5.8
6:57 a. m....	712.9	15.2	79	s.	5.4	873	684.6	20.1	75	ssw.	18.3
7:04 a. m....	712.9	16.0	74	s.	4.5	1,146	663.4	17.7	79	sw.	19.0
7:12 a. m....	712.9	16.4	73	s.	4.9	1,574	631.0	17.3	67	sw.	12.2
7:17 a. m....	712.9	16.4	77	s.	4.0	1,784	615.7	15.1	65	sw.	12.5
7:30 a. m....	713.0	16.9	76	s.	3.6	2,227	584.3	9.9	71	sw.	15.8
7:50 a. m....	713.0	17.6	73	s.	4.5	2,671	553.6	5.6	75	sw.	12.2
8:06 a. m....	713.0	17.4	75	s.	4.5	3,023	530.4	2.4	79	sw.	16.2
8:38 a. m....	713.1	17.5	77	se.	4.9	3,529	498.0	− 2.8	95	sw.	18.4
9:05 a. m....	713.1	17.6	77	ese.	6.7	2,725	549.9	4.3	80	sw.	14.8
9:20 a. m....	713.1	18.0	73	ese.	6.7	2,295	579.4	9.4	71	sw.	13.5
9:35 a. m....	713.2	18.6	76	ese.	8.0	1,786	615.7	14.4	63	sw.	13.0
9:51 a. m....	713.2	19.0	78	ese.	6.7	1,149	663.4	18.1	71	sw.	14.4
9:58 a. m....	713.2	18.5	82	se.	7.2	896	683.2	19.7	73	ssw.	11.6
10:02 a. m....	713.2	18.6	81	se.	8.0	611	706.2	17.0	87	sse.	....
10:03 a. m....	713.2	18.6	81	se.	8.0	526	713.2	18.6	81	se.	8.0

May 26, 1912.—Five kites were used; lifting surface, 35 sq. m. Wire out, 4,000 m.; at maximum altitude, 3,400 m.

A few Cu., from the northwest, appeared at intervals.

High pressure (768 mm.), central over West Virginia, covered the eastern United States.

May 27, 1912.—Six kites were used; lifting surface, 39.8 sq. m. Wire out, 6,130 m.; at maximum altitude, 4,000 m.

Ci., from the west, decreased from 7/10 to 2/10.

High pressure (766 mm.) was central over southern New Jersey. Low pressure (740 mm.) was central over North Dakota.

May 28, 1912.—Six kites were used; lifting surface, 38.8 sq. m. Wire out, 6,100 m.; at maximum altitude, 5,400 m.

Ci.-St. from the west and A.-Cu. from the southwest covered 4/10 to 7/10 of the sky. There were also 1/10 Cu. from the south at 8:20 a. m.

Low pressure (745 mm.) was central over Minnesota, with a secondary (747 mm.) over northeastern Quebec.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind. Direction.	Wind. Velocity.	Height.	Pressure.	Temperature.	Rel. hum.	Wind. Direction.	Wind. Velocity.
May 30, 1912:	*mm.*	*°C.*	*%*		*m.p.s.*	*m.*	*mm.*	*°C.*	*%*		*m.p.s.*
6:34 a.m.....	712.3	15.5	87	wnw.	15.2	526	712.3	15.5	87	wnw.	15.2
6:38 a.m.....	712.3	15.5	87	wnw.	15.2	850	685.7	14.6	82	nw.	19.4
6:39 a.m.....	712.3	15.5	87	wnw.	15.2	883	683.0	15.8	73	nw.	19.4
6:53 a.m.....	712.4	15.8	86	wnw.	14.3	1,017	672.3	15.8	68	nw.	17.0
7:08 a.m.....	712.4	16.0	86	wnw.	13.4	1,135	663.2	17.0	62	nw.	11.1
7:47 a.m.....	712.5	16.2	86	wnw.	13.4	1,806	612.8	10.8	60	wnw.	7.1
8:18 a.m.....	712.7	17.3	83	wnw.	17.0	2,277	579.0	5.2	71	wnw.	7.1
8:47 a.m.....	713.1	17.6	78	wnw.	15.2	1,414	642.1	15.5	56	wnw.	5.1
9:20 a.m.....	713.3	17.6	76	wnw.	15.2	1,291	651.6	13.6	64	nw.	16.9
9:22 a.m.....	713.3	17.5	76	wnw.	15.2	1,161	661.8	12.0	70	nw.	16.9
9:29 a.m.....	713.4	17.6	75	wnw.	17.0	895	683.1	13.4	82	nw.	18.9
9:35 a.m.....	713.4	17.8	75	nw.	16.5	526	713.4	17.8	75	nw.	16.5
May 31, 1912:											
6:26 a. m.....	718.2	11.2	82	wnw.	8.5	526	718.2	11.2	82	wnw.	8.5
6:40 a. m.....	718.3	11.5	79	wnw.	8.9	1,038	675.3	7.1	72	nw.	16.3
6:58 a. m.....	718.5	11.7	77	wnw.	8.9	1,820	614.8	9.3	22	nw.	18.6
7:02 a. m.....	718.5	11.8	76	wnw.	8.9	2,049	597.9	7.8	24	nw.	20.4
7:09 a. m.....	718.6	12.1	72	wnw.	8.9	2,288	581.0	8.2	18	nw.	20.4
7:32 a. m.....	718.7	12.6	63	wnw.	9.4	3,031	530.8	3.9	13	nw.	25.5
7:50 a. m.....	718.8	13.0	61	wnw.	8.9	3,732	486.6	− 3.3	18	wnw.	30.6
7:55 a. m.....	718.8	13.2	60	wnw.	8.0	4,068	466.5	− 2.9	19	wnw.	30.6
8:21 a. m.....	718.8	13.6	56	wnw.	11.2	3,354	510.2	2.1	24	nw.	25.5
8:53 a. m.....	718.8	14.0	56	wnw.	9.8	2,454	569.8	6.9	22	nw.	21.4
9:00 a. m.....	718.8	14.2	56	wnw.	10.7	2,122	593.1	8.4	21	nw.	17.3
9:03 a. m.....	718.8	14.2	55	wnw.	9.8	1,987	602.8	7.1	21	nw.	17.3
9:15 a. m.....	718.8	14.9	59	wnw.	8.5	1,619	630.4	8.1	16	nw.	16.3
9:23 a. m.....	718.8	15.0	55	wnw.	8.9	1,451	643.2	9.8	14	wnw.	15.1
9:25 a. m.....	718.8	15.1	53	wnw.	10.3	1,334	652.4	6.0	13	wnw.	11.5
9:38 a. m.....	718.8	15.3	49	wnw.	10.7	1,018	677.9	8.7	45	wnw.	14.3
9:47 a. m.....	718.8	15.6	48	wnw.	9.8	526	718.8	15.6	48	wnw.	9.8
June 2, 1912:											
6:50 a. m.....	716.6	23.1	65	wsw.	6.3	526	716.6	23.1	65	wsw.	6.3
7:02 a. m.....	716.6	23.2	64	wsw.	5.8	1,006	678.3	20.9	61	wsw.	13.0
7:16 a. m.....	716.6	23.7	63	wsw.	5.4	1,491	641.3	16.5	59	wsw.	12.8
7:35 a. m.....	716.5	23.5	65	wsw.	8.5	1,828	616.1	12.6	54	wsw.	8.7
8:13 a. m.....	716.5	24.0	63	w.	5.8	2,164	591.9	8.6	60	wsw.	11.7
8:24 a. m.....	716.5	24.2	65	w.	6.7	2,724	552.7	2.3	60	sw.	14.7
9:03 a. m.....	716.4	24.8	65	w.	5.8	3,378	509.1	− 3.5	79	wsw.	19.9
9:06 a. m.....	716.4	24.9	64	w.	5.8	3,642	492.8	− 1.3	82	wsw.	19.4
9:21 a. m.....	716.4	25.0	61	w.	7.2	4,109	464.6	− 5.1	35	wsw.	19.0
9:33 a. m.....	716.3	25.3	60	wsw.	5.4	3,621	494.0	− 2.3	30	sw.	18.7
9:37 a. m.....	716.3	25.6	58	wsw.	4.9	3,530	499.8	− 2.8	29	sw.	18.7
9:39 a. m.....	716.3	25.7	58	wsw.	4.0	3,401	507.9	− 2.3	26	sw.	18.7
9:58 a. m.....	716.3	26.2	53	wsw.	4.0	2,650	557.5	4.0	56	sw.	16.3
10:13 a. m.....	716.3	26.2	57	wsw.	4.5	1,991	604.0	10.8	65	sw.	15.3
10:23 a. m.....	716.3	26.2	57	sw.	5.4	1,517	638.9	15.5	61	sw.	14.8
10:37 a. m.....	716.3	26.4	54	sw.	5.4	735	699.5	22.6	56	sw.	9.1
10:41 a. m.....	716.3	26.4	51	sw.	3.4	526	716.3	26.4	51	sw.	3.4

May 30, 1912.—Six kites were used; lifting surface, 37.8 sq. m. Wire out, 6,100 m., at maximum altitude.

There were 7/10 to 3/10 A.-Cu., from the west, until 8 a. m. Thereafter there were 2/10 to 3/10 St.-Cu. from the northwest.

High pressure (766 mm.) was central over Illinois. Low pressure (757 mm.) was central over New Jersey.

May 31, 1912.—Five kites were used; lifting surface, 32 sq. m. Wire out, 5,000, at maximum altitude.

There were few to 4/10 Ci. from the northwest.

High pressure (767 mm.) was central over Ohio. Low pressure (757 mm.) was central off the coast of Massachusetts.

June 2, 1912.—Seven kites were used; lifting surface, 46.6 sq. m. Wire out, 6,200 m.; at maximum altitude, 5,700 m.

Ci.-St., A.-Cu., and Cu., from the west-southwest, diminished from 8/10 to 4/10 by 8 a. m. Thereafter Ci.-St., from the southwest, covered the sky.

Low pressure (756 mm.) was central north of the lower Lakes. Pressure (767 mm.) was high over the Atlantic.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
June 3, 1912:	*mm.*	°*C.*	%		*m.p.s.*	*m.*	*mm.*	°*C.*	%		*m.p.s.*
8:18 a. m....	716.4	18.6	68	nw.	16.1	526	716.4	18.6	68	nw.	16.1
8:27 a. m....	716.4	18.7	72	nw.	14.3	896	686.0	13.1	76	nw.	17.8
8:34 a. m....	716.4	18.8	69	nw.	12.5	1,402	645.8	9.1	82	nw.	13.3
8:45 a. m....	716.4	18.8	66	nw.	13.9	1,464	641.1	12.8	65	nw.	13.8
8:56 a. m....	716.4	18.7	69	nw.	16.1	1,809	615.4	14.4	42	wnw.	10.8
9:01 a. m....	716.4	18.6	68	nw.	16.1	2,180	588.9	10.8	38	wnw.	6.6
9:35 a. m....	716.7	19.4	69	nw.	9.4	2,757	549.8	8.7	23	wnw.	12.2
10:03 a. m....	716.9	19.2	68	nw.	11.6	3,112	526.6	5.7	19	wnw.	11.7
10:12 a. m....	717.0	19.4	66	nw.	11.6	3,693	490.4	0.0	17	wnw.	14.8
10:33 a. m....	717.1	19.3	68	wnw.	9.8	2,805	547.3	6.6	......	wnw.	8.8
10:43 a. m....	717.1	19.8	68	wnw.	8.9	2,109	595.0	13.4	......	wnw.	7.6
10:54 a. m....	717.1	19.9	67	nw.	9.8	1,660	627.3	15.2	......	nw.	10.0
10:58 a. m....	717.1	19.9	67	nw.	9.8	1,448	643.4	10.3	30	nw.	17.8
11:06 a. m....	717.1	19.9	66	nw.	9.8	1,416	645.8	15.5	35	nw.	16.7
11:10 a. m....	717.1	19.7	67	nw.	9.8	1,155	666.1	11.3	62	nw.	11.6
11:20 a. m....	717.0	19.8	66	nw.	8.9	888	687.4	14.4	73	nw.	10.7
11:26 a. m....	717.0	19.8	66	nw.	10.3	526	717.0	19.8	66	nw.	10.3
June 5, 1912:											
6:13 a. m....	718.9	13.2	63	nw.	7.6	526	718.9	13.2	63	nw.	7.6
6:22 a. m....	718.9	13.4	61	wnw.	8.0	1,039	677.2	11.6	54	wnw.	15.8
6:27 a. m....	718.9	13.4	61	nw.	8.0	1,512	639.1	9.3	59	nw.	21.4
6:35 a. m....	719.0	13.4	62	nw.	8.9	1,700	625.0	10.7	36	nw.	18.1
6:37 a. m....	719.0	13.4	62	nw.	8.9	1,779	619.0	10.6	33	nw.	21.2
6:44 a. m....	719.0	13.5	63	nw.	8.0	1,649	628.6	11.9	25	nw.	17.9
6:46 a. m....	719.0	13.5	63	nw.	7.6	1,601	632.2	10.8	23	nw.	18.4
6:47 a. m....	719.0	13.4	62	nw.	7.6	1,511	639.1	10.9	23	nw.	18.4
6:49 a. m....	719.0	13.4	62	wnw.	8.5	1,345	651.8	9.8	27	nw.	20.9
6:52 a. m....	719.0	13.4	62	wnw.	8.5	1,222	661.6	10.8	39	nw.	20.9
7:01 a. m....	719.0	13.5	65	wnw.	8.0	1,043	675.9	9.4	41	nw.	15.9
7:06 a. m....	719.0	13.5	64	wnw.	7.6	687	705.4	11.5	51	nw.	15.3
7:12 a. m....	719.1	13.8	62	wnw.	7.6	526	719.1	13.8	62	wnw.	7.6
June 6, 1912:											
6:26 a. m....	718.1	16.6	85	s.	8.0	526	718.1	16.6	85	s.	8.0
6:41 a. m....	718.1	16.6	87	s.	7.2	1,017	678.2	18.6	87	s.	20.4
7:01 a. m....	718.0	16.6	87	s.	8.0	1,115	670.3	18.0	84	ssw.	20.4
7:24 a. m....	717.8	16.8	85	s.	8.5	1,865	613.6	11.9	79	ssw.	22.4
7:44 a. m....	717.5	17.0	85	s.	8.5	2,636	558.9	5.6	79	sw.	22.4
8:06 a. m....	717.2	17.1	86	s.	8.5	3,218	519.9	− 0.8	67	sw.	21.4
8:35 a. m....	716.8	17.7	85	s.	7.6	4,153	461.8	− 7.8	87	sw.	28.3
9:40 a. m....	716.0	19.8	81	sse.	7.6	3,268	516.2	− 0.4	89	sw.	25.5

June 3, 1912.—Six kites were used; lifting surface, 37.8 sq. m. Wire out, 6,000 m.; at maximum altitude, 5,000 m.

Before 9:45 a. m. there were 7/10 to 5/10 Ci., from the west, A.-St. and St.-Cu., from the northwest. Thereafter Ci.-St., from the west, with a solar halo, and St.-Cu., from the west-northwest, diminished from 6/10 to 4/10.

High pressure (765 mm.) was central over Kentucky. Low pressure was central over Lake Superior (751 mm.) and over the St. Lawrence Valley (752 mm.).

June 5, 1912.—Three kites were used; lifting surface, 19.4 sq. m. Wire out, 2,500 m.; at maximum altitude, 1,950 m.

There were 9/10 Ci.-St., from the west. A solar halo was visible after 6:22 a. m.

High pressure (768 mm.), central over Ohio, covered the eastern half of the United States. Pressure was low (754 mm.) over the Gulf of St. Lawrence.

June 6, 1912.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 6,250 m.; at maximum altitude, 5,800 m.

Ci.-Cu., from the west, A.-Cu. and St.-Cu., from the southwest, covered 9/10 to 3/10 of the sky before 9:30 a. m.; thereafter there were 5/10 to 7/10 Ci., from the west, and A.-St. and Cu.-Nb., from the southwest. First thunder heard 11:05 a. m.; rain began 11:17 a. m.

High pressure (767 mm.) was central over the Atlantic, and low pressure (757 mm.) was central over Ontario.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
June 6, 1912:	*mm.*	*°C.*	%		*m.p.s.*	*m.*	*mm.*	*°C.*	%		*m.p.s.*
10:10 a. m....	715.7	21.3	78	sse.	7.6	2,496	567.4	6.3	79	sw.	21.4
10:36 a. m....	715.4	20.7	81	s.	8.5	1,789	617.3	13.4	69	sw.	23.5
10:49 a. m....	715.4	21.8	79	sse.	8.9	1,475	640.8	14.8	78	sw.	22.4
11:01 a. m....	715.3	22.2	79	s.	9.5	1,158	665.0	18.6	74	sw.	17.8
11:07 a. m....	715.2	22.2	78	s.	8.9	1,053	672.9	19.5	73	sw.	16.8
11:10 a. m....	715.2	21.9	80	s.	8.0	784	694.3	18.4	86	sw.	15.8
11:17 a. m....	715.2	21.2	80	s.	7.2	526	715.2	21.2	80	s.	7.2
June 7, 1912:											
7:47 a. m....	718.3	11.6	70	nw.	12.1	526	718.3	11.6	70	nw.	12.1
8:00 a. m....	718.3	12.3	68	nw.	6.7	1,047	674.5	5.5	72	nw.	13.6
8:12 a. m....	718.3	12.6	66	nw.	8.5	1,788	615.9	3.4	41	nw.	26.5
8:23 a. m....	718.3	12.5	64	nw.	7.6	2,368	573.4	1.3	27	wnw.	24.9
8:38 a. m....	718.4	12.6	61	nw.	9.8	2,971	531.9	− 0.6	31	w.	28.1
8:58 a. m....	718.4	12.7	62	nw.	10.3	3,776	480.1	− 6.2	23	w.	....
9:27 a. m....	718.4	12.9	65	wnw.	10.7	3,037	526.9	− 1.4	16	wnw.	....
9:38 a. m....	718.5	13.0	67	wnw.	8.5	2,558	559.7	− 0.1	15	wnw.	20.4
10:02 a. m....	718.5	13.3	62	nnw.	6.7	1,679	624.3	1.8	20	nnw.	18.9
10:06 a. m....	718.5	13.0	63	nnw.	7.6	1,453	642.1	0.9	28	nnw.	16.3
10:14 a. m....	718.5	13.1	60	nnw.	7.2	892	687.7	7.9	63	nnw.	....
10:30 a. m....	718.6	13.3	59	nnw.	8.0	526	718.6	13.3	59	nnw.	8.0
June 8, 1912:											
6:28 a. m....	721.7	7.7	76	nnw.	4.5	526	721.7	7.7	76	nnw.	4.5
6:43 a. m....	721.8	8.3	76	n.	3.6	913	688.6	3.6	71	nne.	15.3
7:05 a. m....	721.9	8.4	75	n.	4.5	1,523	638.5	− 0.5	67	n.	11.2
7:33 a. m....	722.0	8.9	76	n.	4.5	1,888	610.0	− 3.5	44	n.	9.4
7:55 a. m....	722.1	9.1	76	n.	3.6	2,048	597.9	− 2.7	33	n.	10.9
8:06 a. m....	722.1	8.8	76	n.	3.6	2,430	569.8	− 3.7	26	n.	11.7
9:10 a. m....	722.1	10.6	67	n.	3.6	2,936	534.4	− 6.4	14	n.	17.8
9:18 a. m....	722.1	11.0	65	n.	3.6	2,340	576.5	− 3.5	14	n.	10.7
9:39 a. m....	722.1	11.1	63	n.	4.9	1,661	628.0	− 1.2	14	n.	8.2
9:40 a. m....	722.1	11.2	62	n.	4.9	1,501	640.8	− 1.4	20	n.	8.2
9:42 a. m....	722.1	11.2	60	n.	4.9	1,296	657.2	0.7	30	n.	8.2
9:49 a. m....	722.1	11.6	61	n.	4.9	1,047	677.9	3.1	60	n.	7.1
10:01 a. m....	722.1	11.8	60	nnw.	4.9	526	722.1	11.8	60	nnw.	4.9
June 9, 1912:											
6:06 a. m....	722.0	9.8	57	w.	5.4	526	722.0	9.8	57	w.	5.4
6:20 a. m....	722.1	10.0	59	wnw.	5.8	704	706.9	12.9	51	nnw.	8.2
6:30 a. m....	722.2	10.1	58	wnw.	6.3	900	690.7	11.8	43	n.	14.8
6:47 a. m....	722.3	10.5	58	wnw.	5.8	1,421	648.9	6.8	39	n.	12.5
7:06 a. m....	722.4	10.7	59	wnw.	5.4	2,136	594.2	− 1.1	45	nne.	14.8
7:29 a. m....	722.5	11.1	58	wnw.	5.8	2,817	545.3	− 5.2	38	nnw.	13.0
8:11 a. m....	722.6	12.3	56	wnw.	6.3	3,284	513.7	− 8.7	30	nnw.	14.3
8:22 a. m....	722.7	12.8	51	wnw.	5.8	2,783	547.6	− 6.1	28	nnw.	13.1
8:36 a. m....	722.7	13.4	50	wnw.	5.4	2,107	596.6	− 0.2	36	n.	13.2
8:56 a. m....	722.8	13.7	51	wnw.	5.4	1,338	655.9	7.5	46	nnw.	10.7
9:06 a. m....	722.8	14.2	53	wnw.	5.4	941	688.1	11.5	47	nnw.	14.9
9:15 a. m....	722.8	14.3	49	wnw.	5.4	526	722.8	14.3	49	wnw.	5.4

June 7, 1912.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 5,000 m., at maximum altitude.

Ci.-St., from the southwest, varied from 4/10 to 7/10, and St.-Cu., from the northwest, from 2/10 to 5/10. A solar halo, observed at 7:47 a. m., continued at the end of the flight.

Low pressure (758 mm.) was central over the middle Gulf and (752 mm.) over Nova Scotia. High pressure (774 mm.) was central over northern Iowa.

June 8, 1912.—Five kites were used; lifting surface, 33.5 sq. m. Wire out, 4,300 m.; at maximum altitude, 3,650 m.

Cu., from the north, increased to 3/10 by 9 a. m.; altitude of base, 1,400 m.

High pressure (772 mm.) was central over eastern Iowa. Low pressure (758 mm.) was central over the Florida peninsula.

June 9, 1912.—Five kites were used; lifting surface, 38.4 sq. m. Wire out, 5,000 m.; at maximum altitude, 3,500 m.

Ci.-St., from the west, varied from 1/10 to 3/10.

High pressure, central over Michigan (773 mm.) and over West Virginia (772 mm.), covered the eastern half of the United States. Low pressure (751 mm.) was central over the Gulf of Mexico.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
June 12, 1912:	*mm.*	*°C.*	%		*m. p. s.*	*m.*	*mm.*	*°C.*	%		*m. p. s.*
6:32 a. m....	717.7	18.6	46	w.	8.0	526	717.7	18.6	46	w.	8.0
6:48 a. m....	717.6	18.6	45	w.	8.0	967	681.8	17.7	42	w.	11.7
7:02 a. m....	717.6	19.0	45	wsw.	8.0	1,467	642.9	12.7	42	w.	14.3
7:22 a. m....	717.6	19.2	47	w.	8.0	2,294	582.0	5.8	29	wnw.	20.4
7:43 a. m....	717.6	19.1	49	w.	8.5	2,787	547.7	3.5	22	wnw.	10.7
8:03 a. m....	717.6	19.0	48	w.	8.5	3,236	518.4	− 0.3	16	w.	21.4
8:40 a. m....	717.4	19.3	58	w.	8.0	3,881	478.2	− 4.1	12	wnw.	26.7
9:09 a. m....	717.2	20.1	51	w.	8.5	3,404	507.6	− 0.8	13	wnw.	22.4
9:36 a. m....	716.9	21.2	50	w.	8.5	2,899	540.4	3.8	12	w.	21.4
9:53 a. m....	716.8	21.4	48	w.	8.5	2,171	590.5	9.3	12	w.	13.3
10:00 a. m....	716.7	21.9	48	w.	7.2	2,135	592.9	9.8	11	w.	14.3
10:01 a. m....	716.7	21.9	48	w.	7.2	2,014	601.4	9.4	11	w.	14.3
10:10 a. m....	716.6	22.0	45	w.	8.5	1,470	641.8	12.0	19	w.	11.7
10:27 a. m....	716.5	22.6	43	w.	8.0	957	681.8	17.6	39	w.	10.7
10:36 a. m....	716.5	22.6	42	w.	8.0	526	716.5	22.6	42	w.	8.0
June 13, 1912:											
6:07 a. m....	713.5	15.0	84	nnw.	8.5	526	713.5	15.0	84	nnw.	8.5
6:10 a. m....	713.5	15.0	84	nnw.	8.5	814	689.6	12.5	89	nnw.	....
6:12 a. m....	713.5	15.0	85	nnw.	8.5	996	674.9	13.1	89	nnw.	12.8
6:23 a. m....	713.5	15.0	85	nnw.	7.6	1,288	651.9	12.5	89	nw.	15.3
6:25 a. m....	713.5	15.0	84	nnw.	7.2	1,364	646.0	12.8	81	nw.	15.3
6:30 a. m....	713.6	15.0	82	nnw.	7.2	1,595	628.7	10.8	87	nw.	16.3
6:43 a. m....	713.6	14.8	85	nnw.	5.8	2,273	579.3	5.6	93	nw.	21.4
6:53 a. m....	713.6	14.4	85	nnw.	7.2	2,413	569.4	7.7	68	wnw.	21.4
7:02 a. m....	713.6	14.6	84	nnw.	7.2	3,127	521.9	2.8	53	wnw.	22.4
7:25 a. m....	713.6	14.9	78	nnw.	8.0	3,641	489.5	− 0.4	40	wnw.	23.2
7:44 a. m....	713.7	14.8	76	nnw.	9.8	4,313	449.8	− 6.0	31	wnw.	28.6
8:28 a. m....	713.7	14.4	76	nnw.	8.0	3,660	488.3	0.1	29	wnw.	24.5
8:50 a. m....	713.8	15.1	73	nnw.	7.6	3,070	525.4	4.7	35	wnw.	22.4
9:09 a. m....	713.8	15.8	74	nnw.	7.6	2,466	565.7	7.0	40	nw.	20.4
9:18 a. m....	713.8	15.9	71	nw.	7.6	2,270	579.3	6.5	58	nw.	20.2
9:24 a. m....	713.8	15.9	71	nw.	7.6	1,882	607.1	7.9	85	nw.	20.2
9:39 a. m....	713.9	16.3	69	nw.	7.2	1,321	649.5	12.5	49	nw.	17.9
9:42 a. m....	713.9	16.4	70	nnw.	7.2	1,065	669.7	9.5	80	nw.	11.3
9:54 a. m....	713.9	15.7	71	nnw.	7.6	526	713.9	15.7	71	nnw.	7.6
June 14, 1912:											
6:17 a. m....	714.5	10.4	59	ese.	9.4	526	714.5	10.4	59	ese.	9.4
6:20 a. m....	714.5	10.4	59	ese.	9.8	653	703.7	9.6	62	se.	17.8
6:27 a. m....	714.6	10.4	62	ese.	10.3	930	680.8	11.2	50	se.	16.1
6:48 a. m....	714.6	10.2	64	ese.	10.3	1,046	671.5	15.6	52	sse.	8.5
7:30 a. m....	714.7	10.4	65	ese.	10.3	1,582	630.1	8.8	57	sse.	7.1
8:08 a. m....	714.8	10.6	68	ese.	9.4	1,987	600.2	7.8	58	s.	6.1
8:10 a. m....	714.8	10.6	69	ese.	9.4	2,054	595.3	8.7	86	s.	7.6

June 12, 1912.—Six kites were used; lifting surface, 38.3 sq. m. Wire out, 6,200 m.; at maximum altitude, 6,100 m.

After 8:30 a. m. there were few to 2/10 Ci., from the west-northwest.

High pressure (767 mm.) was central over North Carolina. Low pressure (754 mm.) was central over Quebec.

June 13, 1912.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 6,250 m., at maximum altitude.

10/10 St., from the northwest, at the beginning, diminished to 2/10 at the close of the flight. After 6:49 a. m., there were 1/10 to 4/10 Ci.-St. and 1/10 to 3/10 A.-Cu., from the northwest. The head kite entered St. at 6:42 a. m.; altitude, 1,700 m.

High pressure (765 mm.) was central over upper Michigan, and low pressure (749 mm.) was central off the Maine coast and (754 mm.) over the middle Gulf coast.

June 14, 1912.—Six kites were used; lifting surface, 37.8 sq. m. Wire out, 6,000 m.; at maximum altitude, 4,750 m.

A.-St., from the west-southwest, and St.-Cu., from the south, covered the sky. The head kite was in St.-Cu., altitude 2,000 m., at 8:12 a. m.

Pressure was high (764 mm.) over New England. Low pressure (754 mm.) was central over South Carolina.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
June 14, 1912:	*mm.*	*°C.*	*%*		*m.p.s.*	*m.*	*mm.*	*°C.*	*%*		*m.p.s.*
8:14 a. m....	714.8	10.6	69	ese.	9.8	1,872	608.6	5.8	74	s.	7.6
8:39 a. m....	714.8	10.8	71	ese.	9.4	1,630	626.6	9.4	53	s.	4.8
9:03 a. m....	714.8	11.1	71	ese.	9.8	1,294	652.2	14.7	44	sse.	9.2
9:15 a. m....	714.8	11.2	71	ese.	9.8	1,097	667.6	13.2	42	sse.	14.2
9:17 a. m....	714.8	11.2	71	ese.	9.8	1,047	671.5	12.0	76	sse.	14.7
9:27 a. m....	714.8	11.4	71	ese.	8.9	739	696.8	8.5	72	sse.	15.1
9:31 a. m....	714.8	11.3	72	ese.	8.9	526	714.8	11.3	72	ese.	8.9
June 15, 1912:											
10:05 a. m....	714.0	11.8	100	sse.	10.3	526	714.0	11.8	100	sse.	10.3
10:10 a. m....	714.0	11.8	100	sse.	9.8	867	685.5	10.5	100	s.	17.0
10:24 a. m....	714.0	12.0	100	sse.	8.9	1,029	672.3	11.0	100	s.	18.8
10:40 a. m....	714.0	12.0	100	sse.	8.9	835	688.2	11.4	100	s.	20.4
11:45 a. m....	714.0	12.1	100	sse.	9.4	526	714.0	12.1	100	sse.	9.4
June 16, 1912:											
1:55 p. m....	714.0	19.8	96	sse.	7.2	526	714.0	19.8	96	sse.	7.2
1:58 p. m....	714.0	19.9	96	sse.	7.2	733	697.1	18.2	83	s.	12.9
2:10 p. m....	714.0	20.6	96	sse.	8.0	852	687.6	23.8	79	sw.	11.4
2:17 p. m....	714.0	20.8	95	sse.	7.6	1,432	643.3	19.0	84	wsw.	17.8
2:32 p. m....	714.0	21.5	94	sse.	7.2	2,081	596.1	12.8	92	w.	21.4
2:51 p. m....	713.9	22.6	89	sse.	6.7	3,021	532.7	7.6	79	wnw.	24.5
3:09 p. m....	713.8	23.0	89	sse.	6.7	3,716	489.1	3.0	75	wnw.	26.5
3:37 p. m....	713.8	23.8	86	sse.	6.3	3,015	532.7	6.0	90	wnw.	24.5
3:56 p. m....	713.8	24.2	87	sse.	6.3	2,116	593.7	11.2	91	w.	21.6
4:05 p. m....	713.8	24.4	85	sse.	6.3	1,766	618.9	15.0	88	w.	17.8
4:15 p. m....	713.8	24.6	85	sse.	5.4	1,435	643.3	19.2	82	wsw.	11.7
4:23 p. m....	713.9	24.3	87	sse.	5.4	891	684.9	23.6	78	sw.	10.7
4:31 p. m....	713.9	24.2	86	sse.	5.4	788	692.9	24.6	82	s.	13.4
4:32 p. m....	713.9	24.3	86	sse.	5.4	685	701.1	23.5	86	s.	....
4:34 p. m....	713.9	24.3	86	sse.	4.9	526	713.9	24.3	86	sse.	4.9
June 17, 1912:											
3:10 p. m....	713.2	24.4	91	wnw.	7.6	526	713.2	24.4	91	wnw.	7.6
3:20 p. m....	713.2	25.0	83	w.	8.0	1,001	675.6	22.3	74	w.	15.3
3:34 p. m....	713.3	25.0	74	w.	8.0	1,544	634.6	17.4	76	w.	20.1
3:48 p. m....	713.3	25.6	71	w.	8.0	2,349	577.2	11.7	73	w.	23.5
3:55 p. m....	713.3	25.9	70	w.	8.0	2,531	564.8	11.7	68	w.	21.8
4:10 p. m....	713.3	26.1	70	w.	6.7	3,278	516.0	6.6	58	w.	23.3
4:25 p. m....	713.4	26.6	69	wnw.	7.2	2,648	556.3	9.6	56	w.	22.1
4:36 p. m....	713.4	26.5	69	wnw.	7.2	2,323	578.4	9.6	76	w.	22.9
4:52 p. m....	713.5	27.2	73	w.	5.4	1,561	633.5	15.7	76	w.	18.4
5:02 p. m....	713.5	26.8	71	w.	5.4	987	677.0	20.9	76	w.	15.3
5:14 p. m....	713.6	26.8	69	w.	6.3	526	713.6	26.8	69	w.	6.3

June 15, 1912.—Two kites were used; lifting surface, 12.6 sq. m. Wire out, 1,100 m., at maximum altitude.

There were dense fog and light rain throughout the flight.

High pressure (766 mm.) was central over Maine. Low pressure (746 mm.) was central over Minneasota.

June 16, 1912.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 5,000 m., at maximum altitude.

There were 7/10 to 3/10 St.-Cu. from the west and a few St. from the south-southeast until 2:30 p. m. Then there were 5/10 Ci. from the west-northwest.

At 8 a. m. pressure was high (767 mm.) over Maine and (765 mm.) over Florida. Low pressure (749 mm.) was central over Lake Huron.

June 17, 1912.—Four kites were used; lifting surface, 27.2 sq. m. Wire out, 4,500 m.; at maximum altitude, 4,350 m.

Ci.-St. and Cu.-Nb., from the west, decreased from 8/10 to 4/10. After 4 p. m., Cu., from the west, increased to 1/10.

At 8 a. m. high pressure (766 mm.) was central over Alabama. Low pressure (751 mm.) was central over the lower St. Lawrence.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 521 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
June 18, 1912:	*mm.*	°*C.*	%		*m. p. s.*	*m.*	*mm.*	°*C.*	%		*m. p. s.*
1:16 p. m.	713.9	22.6	78	wnw.	8.9	526	713.9	22.6	78	wnw.	8.9
1:29 p. m.	713.9	22.2	82	wnw.	8.9	921	682.2	18.9	88	w.	14.3
1:36 p. m.	713.9	22.2	84	wnw.	7.2	1,022	674.2	17.6	93	w.	15.8
1:55 p. m.	713.7	22.2	82	wnw.	8.9	1,792	615.6	12.2	86	w.	17.3
2:06 p. m.	713.7	21.9	81	wnw.	8.9	2,161	589.1	9.0	93	wnw.	20.4
2:10 p. m.	713.7	21.8	81	wnw.	7.6	2,367	574.6	6.8	100	wnw.	18.9
2:34 p. m.	713.7	22.2	76	wnw.	10.3	2,984	532.9	7.0	71	wnw.	28.4
2:58 p. m.	713.7	21.6	76	wnw.	8.9	3,372	508.6	4.6	79	wnw.	28.6
3:08 p. m.	713.6	21.8	78	wnw.	7.6	3,717	487.2	2.1	80	wnw.	30.6
5:03 p. m.	712.7	21.2	73	wnw.	8.9	526	712.7	21.2	73	wnw.	8.9
June 20, 1912:											
6:42 a. m.	714.8	13.8	81	w.	8.5	526	714.8	13.8	81	w.	8.5
6:53 a. m.	714.8	13.9	81	w.	8.5	930	681.4	11.6	80	wnw.	14.8
7:09 a. m.	714.8	14.0	82	wnw.	8.9	1,534	633.8	8.7	64	wnw.	13.8
7:30 a. m.	714.9	14.2	82	wnw.	9.8	1,964	601.7	5.9	59	wnw.	10.2
8:38 a. m.	715.3	15.9	75	wnw.	7.2	2,672	551.8	0.8	60	wnw.	11.8
9:27 a. m.	715.6	17.0	70	w.	10.7	3,217	515.2	− 3.5	60	wnw.	9.0
9:45 a. m.	715.6	17.1	68	wnw.	7.2	2,574	558.0	− 0.2	60	wnw.	9.7
9:58 a. m.	715.7	17.8	70	w.	10.3	2,032	597.0	2.6	60	wnw.	15.3
10:25 a. m.	715.7	17.9	67	w.	8.0	1,366	647.8	7.2	97	wnw.	11.2
10:36 a. m.	715.8	18.0	68	w.	7.2	895	685.5	12.6	77	wnw.	8.7
10:48 a. m.	715.8	18.4	68	nw.	7.6	526	715.8	18.4	68	nw.	7.6
June 21, 1912:											
6:38 a. m.	718.5	16.1	67	w.	4.5	526	718.5	16.1	67	w.	4.5
6:52 a. m.	718.5	16.4	67	w.	4.5	673	706.3	16.4	65	w.	6.6
7:44 a. m.	718.7	16.8	72	w.	4.0	937	684.9	15.1	62	wnw.	6.9
7:47 a. m.	718.8	16.6	72	w.	4.5	526	718.8	16.6	72	w.	4.5
June 24, 1912:											
1:51 p. m.	720.5	23.6	57	se.	6.7	526	720.5	23.6	57	se.	6.7
2:02 p. m.	720.4	23.8	60	se.	5.4	969	684.6	18.8	58	sse.	7.1
2:24 p. m.	720.3	23.6	57	se.	5.8	1,266	661.2	15.2	69	sse.	7.2
3:10 p. m.	720.3	23.6	55	se.	5.8	885	691.2	19.0	56	sse.	10.7
3:17 p. m.	720.2	23.4	54	se.	5.8	526	720.2	23.4	54	se.	5.8

June 18, 1912.—Four kites were used; lifting surface, 25.7 sq. m. Wire out, 5,500 m., at maximum altitude.

Before 2 p. m. there were 9/10 St.-Cu. from the west-northwest; thereafter there were 6/10 A.-St., from the west, and St.-Cu., from the west-northwest. The head kite was in St.-Cu. momentarily at 2:06 p. m.; altitude, 2,160 m.

At 8 a. m. high pressure (772 mm.) was central over Colorado, and low pressure (747 mm.) was central over Nova Scotia.

June 20, 1912.—Six kites were used; lifting surface, 37.8 sq. m. Wire out, 6,200 m.; at maximum altitude, 5,100 m.

From 7:20 until 9:20 a. m., there were a few Ci.-St., from the west-southwest; thereafter Cu., from the west-northwest, increased to 5/10. The head kite was momentarily in Cu. at 10:12, 10:21, and 10:27 a. m.; altitude of base, 1,350 m.

Low pressure (756 mm.) was central over Quebec. High pressure (767 mm.) was central over eastern Texas.

June 21, 1912.—Two kites were used; lifting surface, 15.1 sq. m. Wire out, 800 m. at maximum altitude, 480 m.

There were a few A.-St., with no apparent direction, on the southeast horizon.

High pressure (767 mm.) was central over eastern Tennessee, and low pressure (761 mm.) was central over New Brunswick.

June 24, 1912.—Two kites were used; lifting surface, 15.1 sq. m. Wire out, 1,200 m. at maximum altitude, 1,000 m.

There were 6/10 Ci. and Ci.-St., and a few Cu., from the south-southeast. A solar halo was visible after 3 p. m.

High pressure (768 mm.) was central over Virginia, and low pressure (759 mm.) was central over the Gulf of St. Lawrence.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
June 25, 1912:	*mm.*	*°C.*	*%*		*m. p. s.*	*m.*	*mm.*	*°C.*	*%*		*m. p. s.*
10:19 a. m.....	718.9	19.5	89	se.	6.9	526	718.9	19.5	89	se.	6.9
10:24 a. m.....	718.8	19.4	89	se.	6.3	692	705.2	18.0	89	se.	8.1
11:20 a. m.....	718.5	20.0	92	se.	5.4	1,095	672.2	14.0	92	se.	10.3
11:31 a. m.....	718.4	19.8	89	se.	4.5	668	706.6	16.9	92	se.	......
11:34 a. m.....	718.4	19.9	90	se.	4.9	526	718.4	19.9	90	se.	4.9
June 26, 1912:											
6:39 a. m.....	716.8	19.6	88	w.	6.7	526	716.8	19.6	88	w.	6.7
6:42 a. m.....	716.8	19.6	88	w.	6.7	575	712.8	19.5	81	wnw.	7.7
7:38 a. m.....	716.8	20.0	86	w.	4.9	842	691.2	21.0	72	wnw.	8.2
7:49 a. m.....	716.8	20.4	86	w.	5.4	945	683.1	20.0	73	wnw.	7.6
8:46 a. m.....	716.9	20.8	86	w.	5.8	1,446	644.4	17.2	74	nw.	9.9
8:58 a. m.....	716.9	21.5	86	w.	4.9	860	689.8	19.6	74	wnw.	8.8
9:06 a. m.....	716.9	21.4	81	wnw.	5.4	526	716.9	21.4	81	wnw.	5.4
June 27, 1912:											
3:50 p. m.....	718.5	19.6	93	e.	5.8	526	718.5	19.6	93	e.	5.8
3:56 p. m.....	718.5	19.6	93	e.	6.7	659	707.6	18.1	96	ese.	8.2
4:01 p. m.....	718.5	19.6	95	e.	6.7	925	686.0	16.6	100	ese.	8.7
4:14 p. m.....	718.5	19.6	93	e.	7.2	1,313	655.2	13.2	99	ese.	9.7
4:24 p. m.....	718.5	19.8	93	e.	6.3	1,495	641.3	11.8	96	ese.	9.7
4:25 p. m.....	718.5	19.8	93	e.	6.3	1,618	632.0	12.2	85	ese.	12.8
4:35 p. m.....	718.5	19.8	93	ese.	6.7	1,941	608.0	10.1	88	e.	13.8
4:51 p. m.....	718.4	19.5	94	e.	8.0	2,138	593.5	10.2	75	....	16.3
5:07 p. m.....	718.4	19.0	96	e.	7.2	1,900	610.3	9.7	99	....	11.2
5:14 p. m.....	718.5	18.7	97	e.	7.6	1,804	617.6	0.4	99	ese.	14.3
5:29 p. m.....	718.6	18.4	98	e.	8.0	1,340	652.8	12.3	100	ese.	11.2
5:40 p. m.....	718.7	18.2	99	e.	7.6	791	696.8	14.6	100	e.	14.3
5:46 p. m.....	718.7	18.2	99	e.	7.2	526	718.7	18.2	99	e.	7.2
June 29, 1912:											
6:23 a. m.....	718.8	19.7	92	w.	7.2	526	718.8	19.7	92	w.	7.2
6:32 a. m.....	718.9	19.8	91	w.	7.6	895	689.0	21.3	67	wnw.	14.8
6:47 a. m.....	718.9	20.4	88	w.	8.5	1,377	651.6	18.0	74	nw.	13.4
7:01 a. m.....	718.9	20.6	88	w.	7.6	1,704	627.2	16.2	66	nw.	10.2

June 25, 1912.—Two kites were used; lifting surface, 13.1 sq. m. Wire out, 1,100 m.; at maximum altitude, 1,000 m.

The sky was overcast with St.-Cu., from the southeast. Light rain fell from 10:34 to 10:55 a. m. The head kite entered the St.-Cu. at 10:25 a. m., altitude 800 m.

High pressure (770 mm.) was central over the south Atlantic coast. Low pressure (758 mm.) was central over Lake Superior.

June 26, 1912.—Four kites were used; lifting surface, 28.7 sq. m. Wire out, 1,860 m.; at maximum altitude, 1,650 m.

Ci.-St., from the west, increased from 8/10 to 10/10. A solar halo was visible after 8:50 a. m.

Low pressure was central over the Gulf of St. Lawrence (751 mm.) and over southern Alabama (760 mm.). Pressure was high (767 mm.) east of the South Atlantic States.

June 27, 1912.—Five kites were used; lifting surface, 33.5 sq. m. Wire out, 3,700 m.; at maximum altitude, 3,200 m.

The sky was covered with St.-Cu., from the east-southeast, before 5:30 p. m.; and then with St., from the east, and light fog. The head kite entered St.-Cu. at 3:56 p. m., altitude 650 m., and emerged from St. just before landing, less than 100 m. above the surface.

At 8 a. m. high pressure (769 mm.) was central over Vermont, and low pressure (759 mm.) was central over the lower Mississippi Valley.

June 29, 1912.—Seven kites were used; lifting surface, 45.6 sq. m. Wire out, 6,200 m.; at maximum altitude, 4,300 m.

Ci. and Ci.-Cu., from the west-southwest, decreased from 8/10 to none by 9 a. m.

Low pressure (753 mm.) was central over Newfoundland. Pressure was high over the South Atlantic States (767 mm.) and over Lake Superior (765 mm.).

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.					
	Pressure.	Temperature.	Rel. hum.	Wind.		Height.	Pressure.	Temperature.	Rel. hum.	Wind.	
				Direction.	Velocity.					Direction.	Velocity.
June 29, 1912:	*mm.*	°*C.*	%		*m. p. s.*	*m.*	*mm.*	°*C.*	%		*m. p. s.*
7:18 a. m.....	718.9	20.4	88	w.	7.6	2,033	603.2	13.7	68	nw.	9.2
8:16 a. m.....	718.8	21.4	86	wnw.	9.4	2,363	580.2	11.0	65	wnw.	7.2
8:26 a. m.....	718.8	21.8	86	wnw.	9.8	2,595	564.1	8.7	68	wnw.	6.8
8:35 a. m.....	718.7	22.0	86	w.	12.1	2,016	604.4	13.6	56	w.	7.0
8:57 a. m.....	718.7	22.6	86	wnw.	11.2	1,671	629.6	17.3	43	wnw.	9.5
9:09 a. m.....	718.7	22.6	86	wnw.	11.6	1,391	650.4	17.5	55	nw.	16.8
9:26 a. m.....	718.7	23.4	81	wnw.	9.4	912	687.6	20.6	66	wnw.	15.8
9:34 a. m.....	718.7	23.4	79	wnw.	11.6	526	718.7	23.4	79	wnw.	11.6
June 30, 1912:											
6:24 a. m.....	717.4	19.4	81	nw.	9.8	526	717.4	19.4	81	nw.	9.8
6:35 a. m.....	717.4	19.2	81	nw.	12.1	1,041	675.7	17.7	80	wnw.	13.8
6:56 a. m.....	717.5	19.3	81	nw.	9.8	1,196	663.9	20.2	60	nw.	9.7
7:01 a. m.....	717.5	19.2	82	nw.	9.8	1,635	630.8	16.4	68	nnw.	10.2
7:52 a. m.....	717.6	19.3	81	nw.	8.9	1,998	604.4	12.3	75	nnw.	8.2
8:26 a. m.....	717.7	19.3	83	nw.	8.9	2,503	569.0	6.9	78	nw.	9.5
8:36 a. m.....	717.7	19.2	85	nw.	9.4	3,375	510.6	0.4	95	nw.	....
8:55 a. m.....	717.9	19.6	85	nw.	6.7	2,624	559.2	4.5	82	nw.	11.7
9:09 a. m.....	718.0	20.0	81	nw.	6.7	1,937	607.9	10.6	79	nnw.	11.7
9:21 a. m.....	718.0	20.2	82	nw.	4.0	1,262	658.8	13.3	93	nnw.	11.2
9:30 a. m.....	718.1	20.6	81	nw.	4.0	849	691.7	17.4	88	nnw.	9.7
9:35 a. m.....	718.1	20.8	80	nnw.	4.0	526	718.1	20.8	80	nnw.	4.0

June 30, 1912.—Seven kites were used; lifting surface, 44.6 sq. m. Wire out, 6,200 m.; at maximum altitude, 4,200 m.

There were 10/10 to 4/10 A.-St. and St.-Cu., from the west-northwest, before 9 a. m.; thereafter there were 5/10 to 9/10 St.-Cu. from the north-northwest. The head kite was in St.-Cu., altitude 1,200 m., from 9:10 to 9:22 a. m. Light rain began at 6:47 and ended at 8:23 a. m.

High pressure (770 mm.) was central over Ontario, and low pressure (748 mm.) was central over Newfoundland.

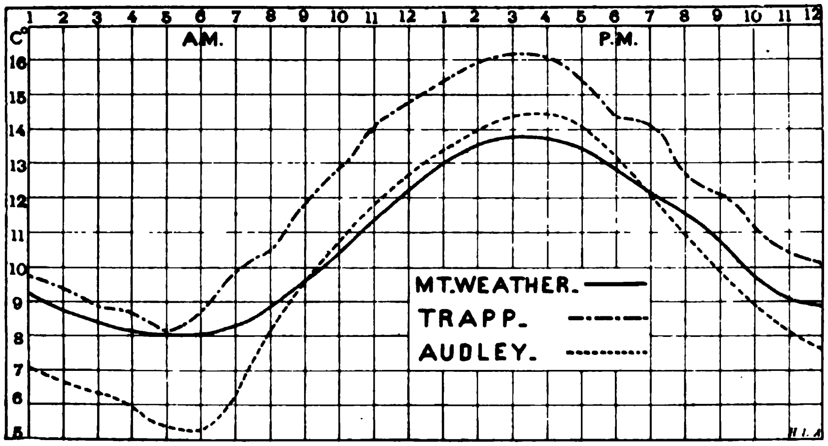

FIG. 14.—Mean hourly temperature for April, 1912.

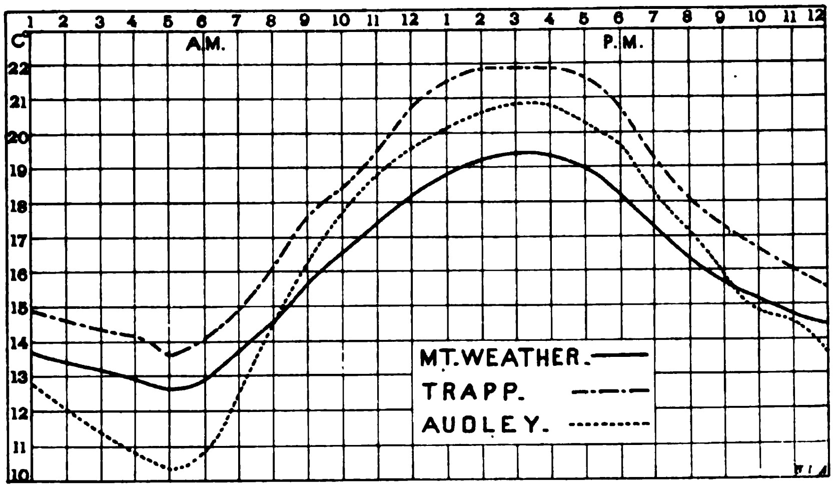

FIG. 15.—Mean hourly temperature for May, 1912.

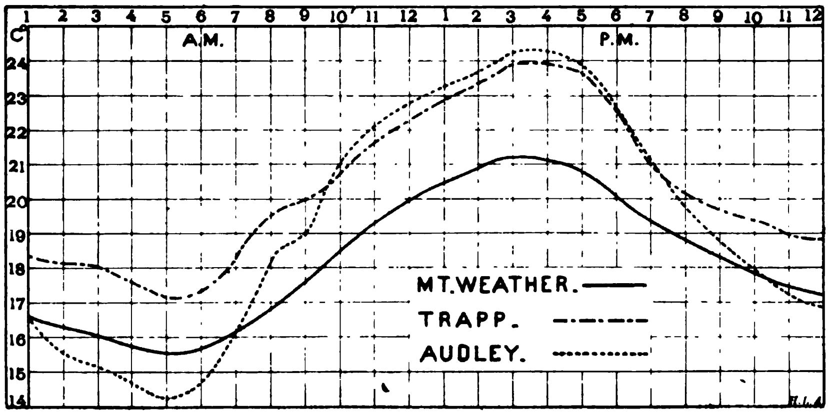

FIG. 16.—Mean hourly temperature for June, 1912.

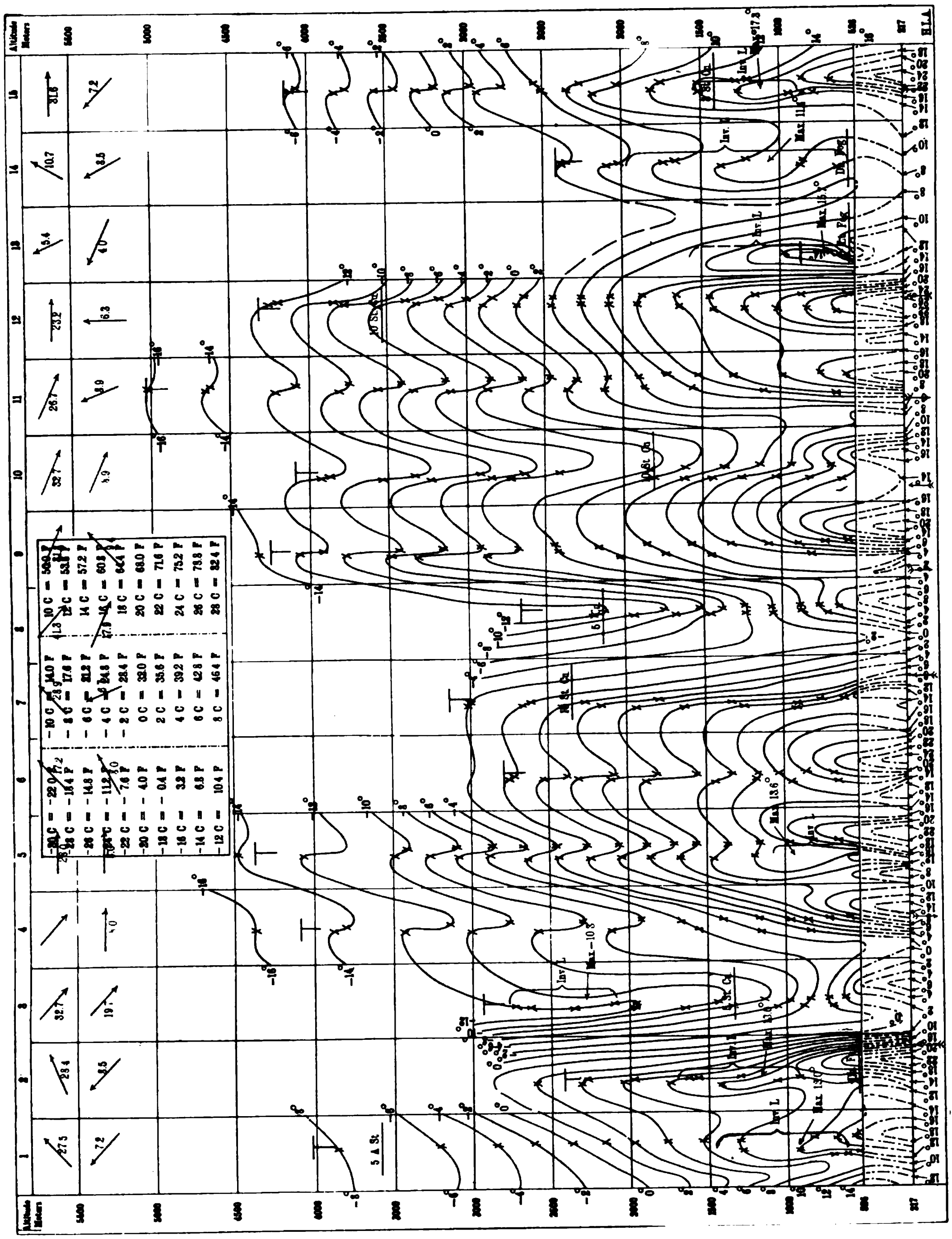

CHART VII.—Free air isotherms, April 1–15, 1912.

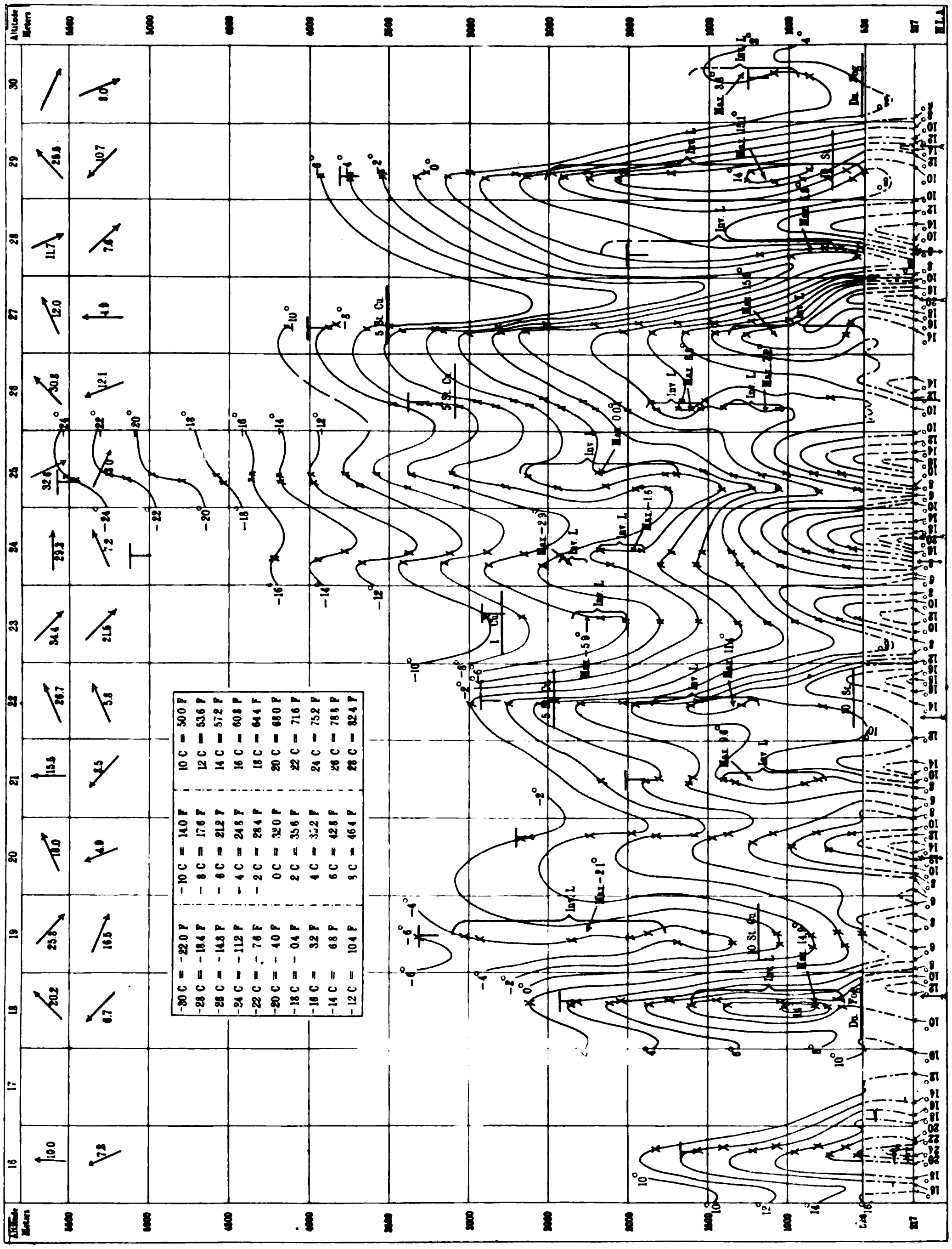

CHART VIII.—Free air isotherms, April 16–30, 1912.

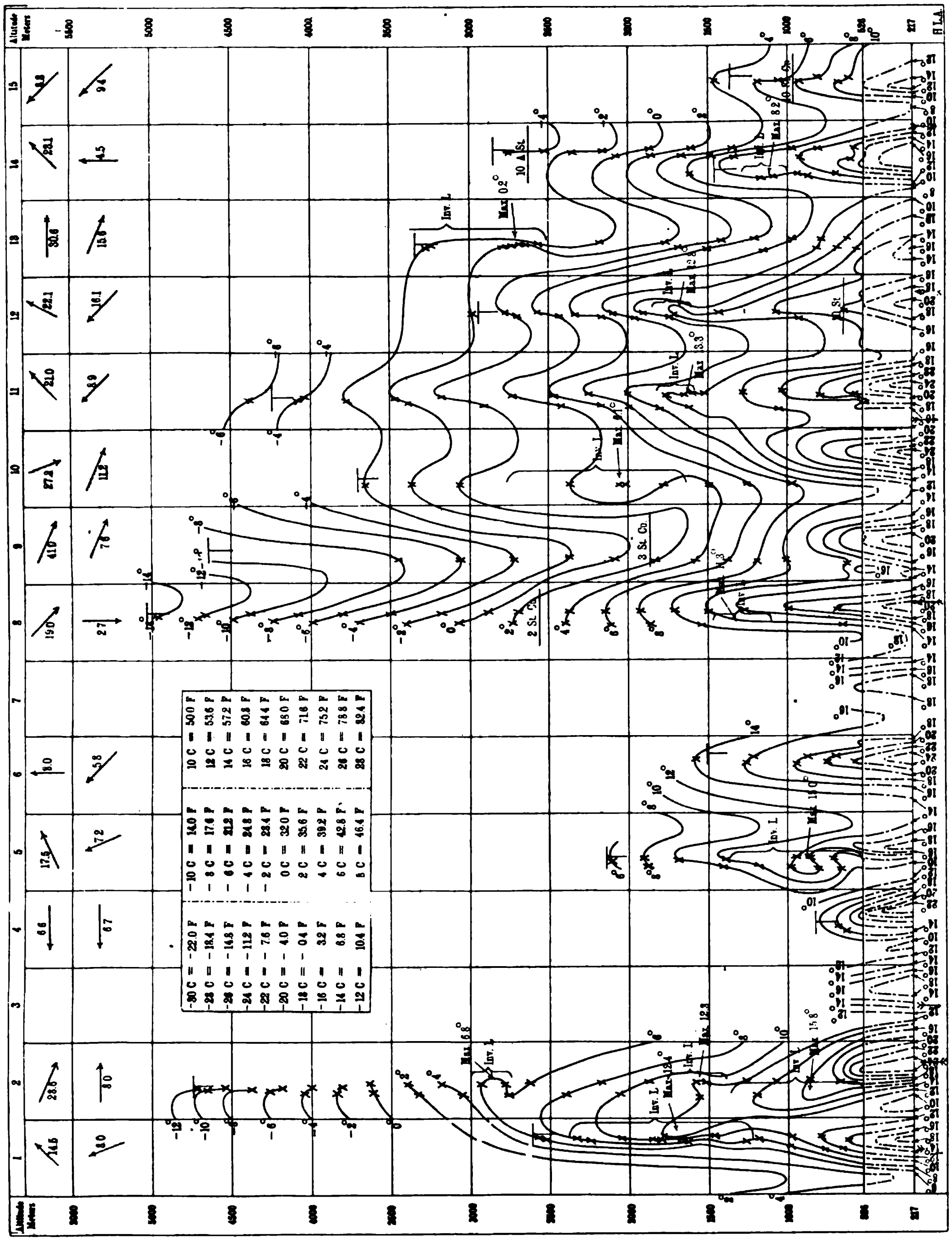

CHART IX.—Free air isotherms, May 1-15, 1912.

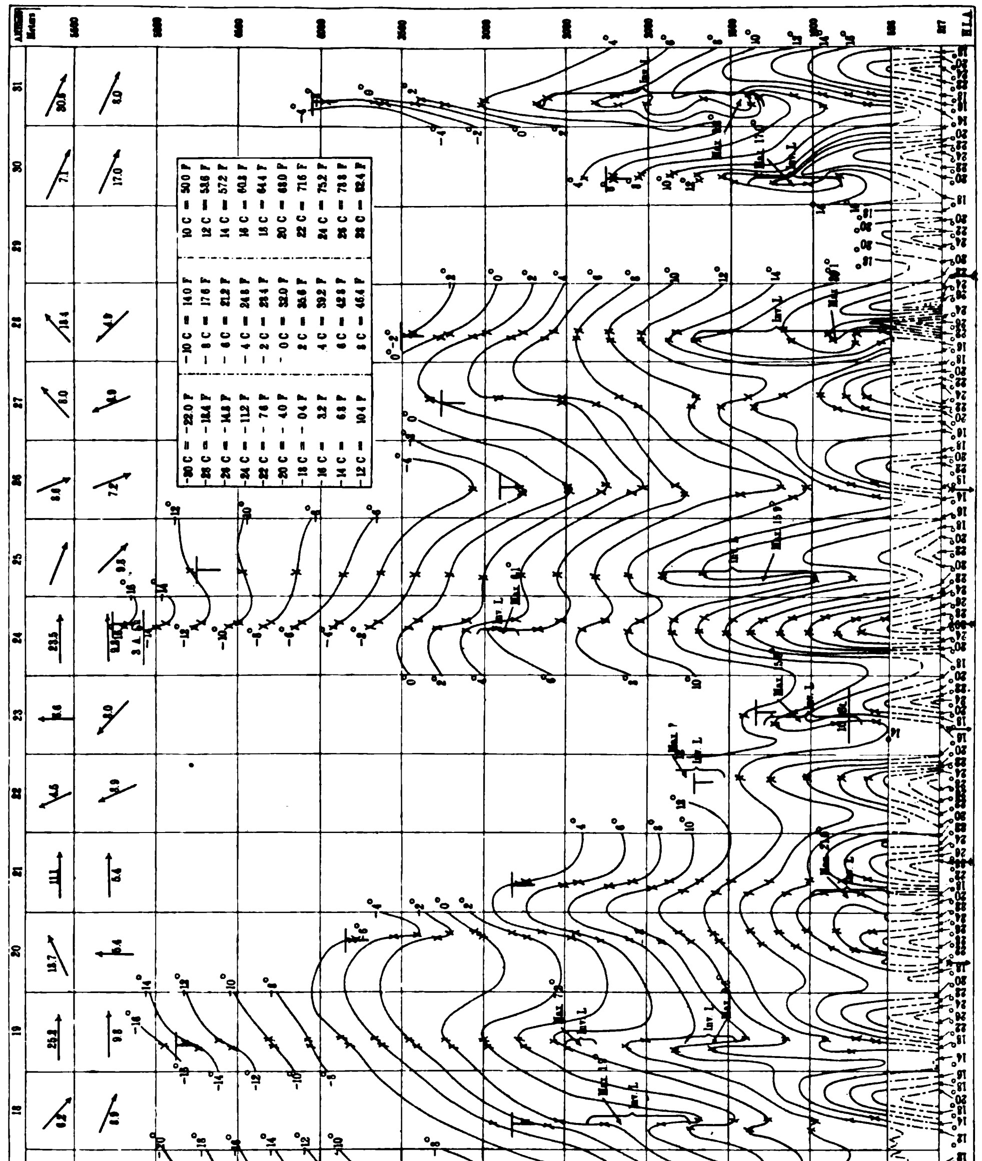

CHART X.—Free air isotherms, May 16-31, 1912.

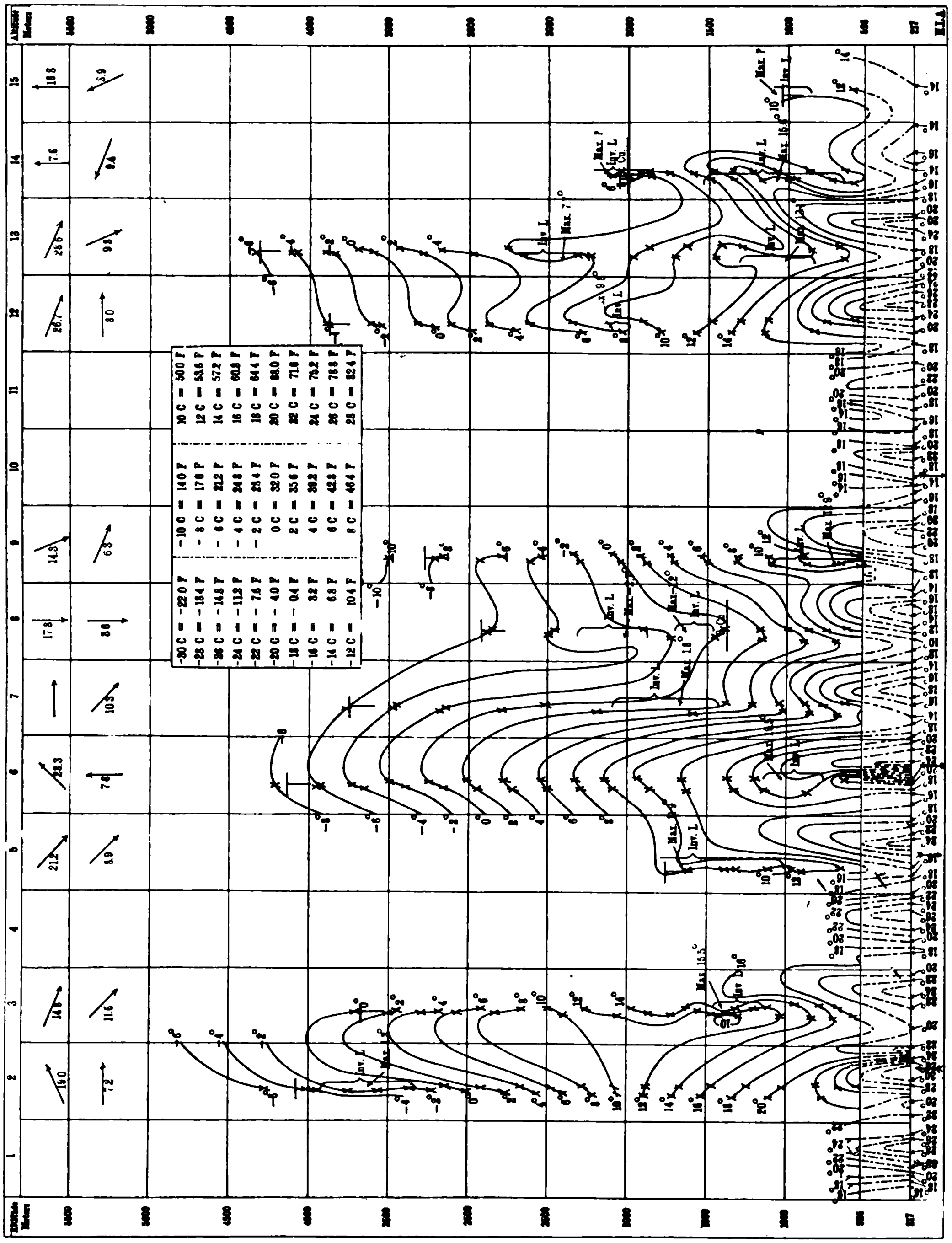

CHART XI.—Free air isotherms, June 1-15, 1912.

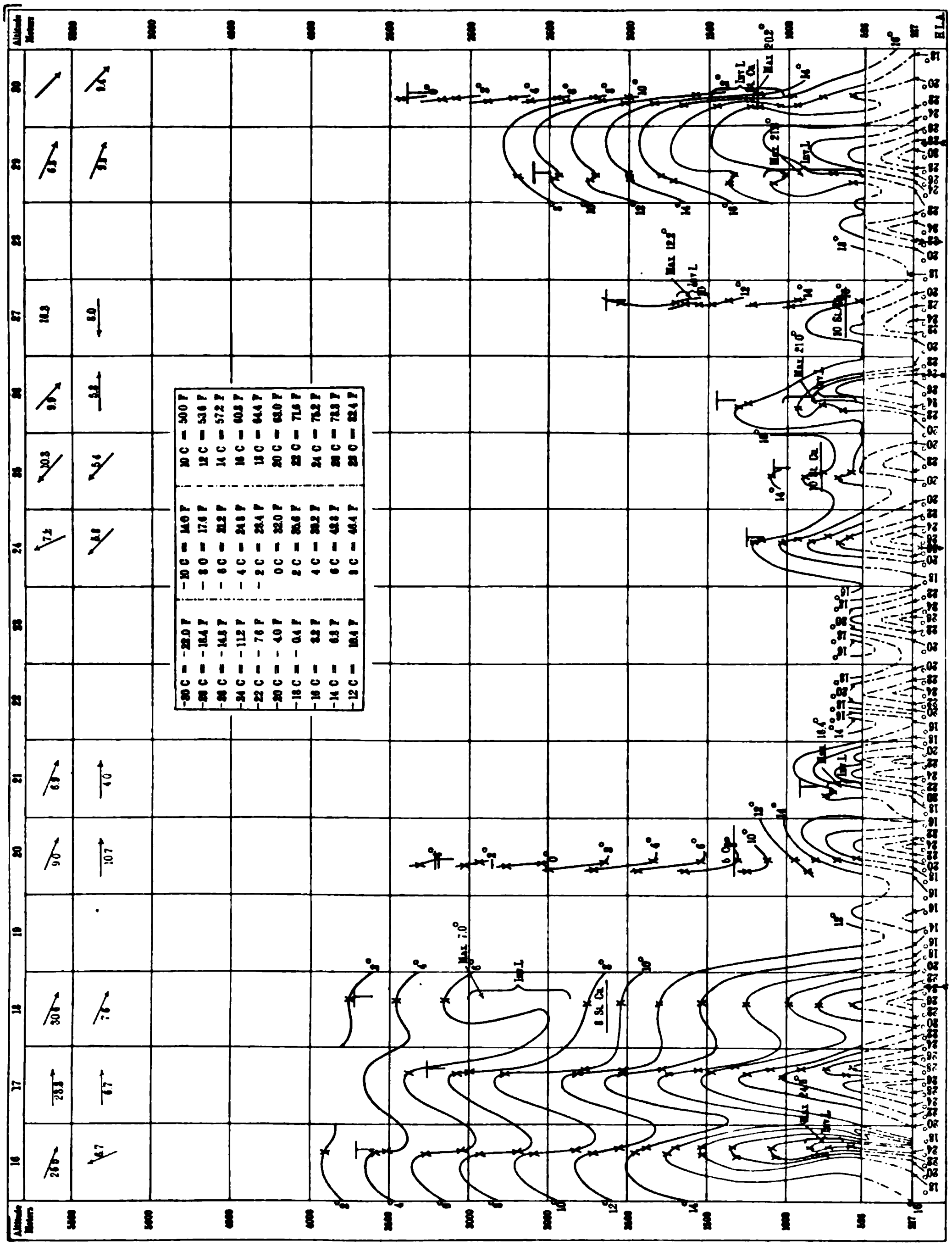

CHART XII.—Free air isotherms, June 16–30, 1912.

BULLETIN

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IX. IS THE AVERAGE OF MEASUREMENTS THE BEST APPROXIMATION FOR THE TRUE VALUE OR NORMAL VALUE?[1]

By EDWARD L. DODD, Ph. D., Austin, Tex.

(Dated Dec. 3, 1912.)[1]

It is not the purpose of this paper to give an ultimate or dogmatic answer to this perplexing question but merely to examine the question from the viewpoint of error-risk.[2]

When measurements have been made upon the same object or quantity under like conditions a common practice is to accept the arithmetic mean—commonly called the "average"—of the measurements as a representative of the whole set. This has sometimes been called the most probable value, or the most plausible value for the unknown true value, in case the true value is supposed to be a constant. In dealing with a quantity essentially variable the average is frequently regarded as the most typical value or the normal value.

This acceptance of the arithmetic mean as the best value or most probable value or normal value has not been unchallenged. Writers[3] on the theory of statistics present the comparative advantages and disadvantages of the arithmetic mean, the median, the mode, the geometric mean, etc. From the mathematical standpoint it is even more simple to find the median than to find the average. We have simply to arrange the measurements in the order of their magnitude; if the number of measurements is odd, the median is the middle one; otherwise some number between the two middle ones.

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[1] This article, kindly communicated by Dr. Dodd, relates to a subject that should be clearly understood by all students of nature. Of course we have so few observations in the upper air in any one place that we should be doubly careful to adopt only sound conclusions. Dr. Dodd's numerous papers on this subject discuss in general the relation between the "law of probability," the "principle of the arithmetic mean," and the "method of least squares," which is almost universally accepted by astronomers, geodesists, and climatologists.—EDITOR.

[2] "Fehlerrisiko," Czuber, Wahrscheinlichkeitsrechnung, I, p. 266.

[3] See, e. g., King's Elements of Statistical Method, Chap. XII. Macmillan, 1912.

After the arithmetic mean or average has been found, very frequently the so-called "*probable error*" is found. Let the n measurements, taken under like circumstances, be designated by m_1, m_2, . . . m_n; the arithmetic mean by M_n or simply M; the "residuals" are then $v_1 = M - m_1$, . . .; $v_n = M - m_n$. With change of sign these would be the "*departures*" from the average; thus the departure, $d_1 = m_1 - M = -v_1$. The commonly accepted formula for the "probable error," r, is

$$r = 0.6745\sqrt{\frac{\Sigma v^2}{n-1}},$$

where Σv^2 means the sum of the squares of the residuals or departures from the average. With r determined thus, it is supposed that about one-half of the measurements will be greater than $M - r$ and at the same time less than $M + r$. This r is a measure for the *variability* of the measurements; the greater the variability, the greater will r be.

Now, this formula for r is deduced from certain principles in the theory of probability. In this theory the *Gaussian Law* [G. L.] plays an important rôle. This law may be expressed as follows: Let a be the "true value" of the unknown, or, in case of a variable, we may say the "normal" value. Let the "errors" or the departures from the normal value, taken negatively, be designated by x_1, x_2, . . . x_n; thus: $x_1 = a - m_1$, $x_2 = a - m_2$, etc. These errors are supposed to be due to chance, compensation having been made for all known imperfections in the measuring instruments. The existence of a number, h, is postulated. This is called the "*measure of precision*," and the commonly accepted approximation for it is

$$h = \sqrt{\frac{n-1}{2\Sigma v^2}}.$$

The Gaussian Law then states that the *probability*, P, that the error, x, will lie in the interval from x' to x'' is

$$P = \frac{h}{\sqrt{\pi}}\int_{x'}^{x''} e^{-h^2x^2}dx,$$

where $x' < x''$. This means that, if n is large, it is to be expected that about nP of the n measurements will have errors greater than x' and at the same time less than x''.

In the theory of measurements it is customary to adopt the Gaussian Law and also the so-called "Principle of the Arithmetic Mean," namely, the statement that the arithmetic mean of n measurements taken under like circumstances is the "most probable value" for the unknown.

Bertrand[1] pointed out the *incompatibility* of the *Gaussian Law* and the *Principle of the Arithmetic Mean.* Nevertheless, each has become so deeply rooted in mathematical soil that this incompatibility has been almost ignored. At one time it was supposed that one logically implied the other; but this illusion is past.

Now, the Gaussian Law is not self-evident; nor is it grounded upon principles that are intuitively discerned. There is, however, a mass of evidence to support it; at present it appears to be about the best instrument, from a mathematical standpoint, to use for judging between the claims for precedence of the arithmetic mean, the geometric mean, the median, and such other functions of the measurements as the human mind can invent.

With this in view, the Gaussian Law may be made the basis for the determination of a "*probable value.*"[2] To illustrate this idea of probable value, suppose that a gambler is to receive \$3 if he throws a three-spot with a die, \$6 if he throws a six-spot, otherwise nothing. On a single throw his chance of getting the three-dollar prize is $\frac{1}{6}$, there being just 6 faces on a die, and his chance of getting the six-dollar prize is $\frac{1}{6}$. His *expectation* is defined to be

$$\tfrac{1}{6}(\$3.00) + \tfrac{1}{6}(\$6.00) = \$1.50;$$

and this is also called the *probable value* of his intake on a single throw. If the gambler should throw the die 60 times and should get the ideal number of three-spots, viz, 10 three spots, and also 10 six-spots, his *actual intake*, \$90, would be the same as if he had received the *probable value*, \$1.50, after *each* throw. The probable value is the expected average value. To get the probable value in cases like this, we multiply each possible value by its probability and take the sum of the products thus formed.

Frequently it is more convenient to deal with the square of an error, or departure, than with the error, or departure, itself. By a generalization of the foregoing definition the probable value of x^2 is, in accordance with the **G. L.**,

$$\frac{h}{\sqrt{\pi}}\int_{\infty}^{\infty} x^2 e^{-h^2x^2}dx.$$

Now, let $m_1, m_2, \cdots m_n$ be measurements with measures of precision, $h_1, h_2, \cdots h_n$, respectively. The error, $a - f(m_1, m_2, \cdots m_n)$ of a function, f, of the n measurements is a function, $F(x_1, x_2, \cdots x_n)$, of the n errors. The probable value of F^2 is defined as

$$\frac{h_1 \cdots h_n}{(\pi)^{\frac{n}{2}}}\int_{-\infty}^{+\infty}\cdots\int_{-\infty}^{+\infty} F^2 e^{-\Sigma h^2x^2}dx_1 \cdots dx_n.$$

[1] Calcul des Probabilités, pp. 177–180.

[2] The so-called "probable error" is not the same as the "probable value of the error."

This is the expected average value of F^2 in accordance with the *G. L.* The square root of this expression is called the *mean-error-risk.*

Of two functions of the measurements, that one with the smaller mean error-risk is the more acceptable from the present viewpoint, as presumably the function which approximates more closely to the true value.

The following theorems were presented in a paper [1] at the meeting of the Southwestern Section of the American Mathematical Society at Lawrence, Kans., November 30, 1912. The true value is designated by a; the measure of precision, if common, by h; the arithmetic mean of n measurements by M_n or M.

Theorem. Under the **G. L.**, the probable value of the square of the error of M is greater than that of BM, if B is any constant such that

$$1-\frac{2}{2nh^2a^2+1}<B<1. \tag{1}$$

Usually, ha is very large. But, if not, then from the standpoint of the "mean error-risk," it is *useless to make any measurements* at all—with the purpose of taking the arithmetic mean—*unless* a sufficient number, n, are made so that

$$2nh^2a^2 \geqq 1. \tag{2}$$

For, if (2) is not satisfied, the risk in accepting zero as the value of the unknown is less than that in accepting M.

A somewhat similar theorem is valid, involving the *absolute value* of the error of M, and another involving *any even power* of the error of M.

Now let

$$M'_n=+\sqrt{\frac{m_1^2+m_2^2+\cdots+m_n^2}{n}},$$

in particular,

$$M'_2=+\sqrt{\frac{m_1^2+m_2^2}{2}}.$$

Theorem. Under the **G. L.**, the probable value of the square of the error of M'_2 is *less* than that of M_2, if $a>0$, and h is sufficiently great.

Theorem. Under the **G. L.**, the probable value of the square of the error of M'_n is *greater* than that of M_n if $n>3$, and h is sufficiently great.

By a weighted mean, W, is meant $p_1m_1+p_2m_2+\cdots+p_nm_n$, where the p's are constants whose sum is unity; and by an absolute error, an error taken positively.

[1] This paper giving the mathematical treatment and proof of these theorems has been offered to the *Monatshefte für Mathematik und Physik.* Some closely related theorems are stated in the Bulletin of the American Mathematical Society, Nov., 1912, pp. 54 and 55.

Theorem. If the measurements are subject to the G. L. with measures of precision, $h_1, h_2, \ldots h_n$, respectively, then the probable value of any given positive power of the absolute error of W is least when $p_i = h_i^2/\Sigma h^2$. In particular, if the h's are all equal, this W with the least error-risk is M.

So far as they go, these theorems indorse the use of the average or arithmetic mean for most purposes, or, in the case of measurements with *different* degrees of precision or reliability, the commonly accepted *weighted mean,* with weights proportional to h_i^2. For in equation (1) the difference between B and unity is usually small; if not, it can be made small by making a large number, n, of observations; usually more than three measurements are taken, and the arithmetic mean is more acceptable than M'_n.

Nevertheless, the theorems suggest that the use of any one function—such as the arithmetic mean—under all circumstances is inadvisable. The superiority of the arithmetic mean becomes more questionable when the variations among the measurements are *large* causing a large "probable error," r, and small measure of precision, h, especially when the *true value* or *normal value,* a, is *small,* and when the *number* of *observations* is *small.*

This suggests the need of theoretical and empirical investigations focused upon the cases in which the arithmetic mean or average appears at a disadvantage.

(X) THE INTERNATIONAL RADIOTELEGRAPH CONFERENCE OF 1912.

The delegates to the International Radiotelegraph Conference assembled on June 4, 1912, in the building of the Institution of Electrical Engineers, Victoria Embankment, London. The sessions were continued without interruption until July 5, when the final meeting was held and the respective delegates signed "the convention," the "final protocol," and the "detailed service regulations" appended thereto, subject to ratification by the Governments or administrations represented at this conference. The following quotations will be interesting from the meteorologists' point of view:

Article I.

The choice of radiotelegraph apparatus and devices to be used by coast stations and ship stations is free. The installation of these stations must, as far as possible, be in keeping with scientific and technical progress.

Article II.

Two wave lengths, one of 600 and the other of 300 meters, shall be allowed for the service of the general correspondence. Every coast station open to this service must be equipped in such a way as to be able to use these two wave lengths, of which one shall be indicated as the normal wave length of the station. During the whole time that it is open, every coast station must be in a condition to receive calls made by means of its normal wave length. Nevertheless, for the correspondence covered by paragraph 2 of Article XXXV, use shall be made of a wave length of 1,800 meters. Further, each Government may authorize the use, in a coast station, of other wave lengths for the purpose of securing a long-range service, or a service other than that of general public correspondence and established in conformity with the provisions of the convention, with the reservation that these wave lengths do not exceed 600 meters or that they do exceed 1,600 meters.

In particular, stations used exclusively for the dispatch of signals intended to determine the position of ships must not use wave lengths exceeding 150 meters.

Article III.

1. Every ship station must be equipped in such a way as to be able to use the wave lengths of 600 meters and of 300 meters. The first shall be the normal wave length, and may not be exceeded in transmission, the case of Article XXXV (paragraph 2) excepted.

Use may be made of other wave lengths not exceeding 600 meters, in special cases, and subject to the approval of the administrations to which the coast stations and ship stations concerned are subject.

2. During the whole time that it is open every ship station must be able to receive calls made by means of its normal wave length.

3. Ships of small tonnage in the case of which it would be materially impossible to use the wave length of 600 meters for transmission may be authorized to employ exclusively the wave length of 300 meters; they must be able to receive by means of the wave length of 600 meters.

ARTICLE IV.

Communications between a coast station and a ship station, or between two ship stations, must be exchanged on both sides by means of the same wave length. If, in a particular case, communication is difficult, the two stations may, by mutual consent, pass from the wave length by means of which they are communicating to the other regulation wave length. Both stations shall resume their normal wave lengths when the radiotelegraphic exchange is finished.

* * * * * * *

ARTICLE XXXV.

1. As a general principle, the ship station shall transmit its radiotelegrams to the nearest coast station.

However, if the ship station has the choice between several coast stations at equal or nearly equal distances, it shall give the preference to that which is established on the territory of the country of destination or of normal transit of its radiotelegrams.

2. Nevertheless, a sender on board a ship shall have the right to indicate the coast station by which he wishes his radiotelegram to be forwarded. The ship station shall then wait until this coast station is the nearest.

Exceptionally, etc.

* * * * * * *

ARTICLE XLV.

1. The administrations shall take the necessary steps to supply their coast stations with meteorological telegrams containing the particulars of interest to the district of such stations. These telegrams, the text of which must not exceed 20 words, shall be sent to the ships which ask for them. The charge for these meteorological telegrams shall be carried to the account of the ships to which they are addressed.

2. The meteorological observations, made by certain ships appointed for that purpose by the country to which they belong, may be sent once a day, as paid-service advices, to the coast stations authorized to receive them by the administrations concerned, who shall also appoint the meteorological offices to which these observations shall be addressed by the coast station.

3. Time signals and meteorological telegrams shall be transmitted in succession one to another in such a way that the total duration of their transmission does not exceed 10 minutes. In principle, while they are being sent, all radiograph stations, transmission by which might disturb the reception of these signals and telegrams, shall keep silent so as to allow all stations which desire to do so to receive these telegrams and signals. An exception shall be made in the case of distress calls and State telegrams.

4. The administrations shall facilitate the communication, to the marine information agencies which they may appoint, of the information respecting wrecks and casualties at sea or presenting a general interest for navigation, which the coast stations can communicate regularly.

The delegates from the United States took advanced grounds upon the proposition giving priority of transmission to weather reports from ships to coast stations and central offices. They secured results that will be of great benefit both to science and humanity. The organization and maintenance of an efficient service for reporting weather conditions and storm warnings was especially urged by Prof. Willis L. Moore, Chief of the Weather Bureau, as a member

of the American delegation, and the benefits of such a service were recognized by all the international delegates.

The text of the above quoted article XLV, paragraphs 2 and 3, but faintly expresses the general conviction of the conference, but the service regulations as eventually adopted will undoubtedly result in action of immeasurable benefit to commerce and humanity. The utility of the proposed service for the Atlantic Ocean and Caribbean Sea will be particularly apparent after the opening of the Panama Canal. The United States is therefore logically called upon to inaugurate and maintain a marine radiotelegraph weather service. It is proposed to gather and chart at the central office of the Weather Bureau in Washington all messages coming westward from the Atlantic, thereby enabling the Weather Bureau to locate ocean storms and forecast their paths far more accurately than could have been done in the years preceding the use of radiotelegraphy.

(XI) ON VIOLENT UPRUSHES IN CUMULUS CLOUDS.

By W. J. Humphreys.

(Dated Dec. 24, 1912.)

Every careful observer of clouds is familiar with the peculiar boiling and tumbling of large cumuli, their formation of new heads, and the other evidences they often give of violent motions and an explosive-like turbulence—evidences most emphatically confirmed by every balloonist who has survived the gloom and frightful violence of such an aerial maelstrom.

Since large cumuli are most frequent during warm summer afternoons, it might seem that the swift uprush they display, and to which in turn they are largely due, is wholly caused by the high surface temperature. But for several reasons it appears that this is not the correct explanation. Vertical convection sets in gently as the ground begins to heat up in the early forenoon, and thus gradually establishes to an increasing depth a vertical temperature gradient that is approximately that of dry air, or a gradient in which the decrease of temperature is nearly 1° C. per 100 meters increase of elevation. Hence no great difference in temperature, nor, therefore, in density, can exist between a mass of rising air (previous to condensation) and the surrounding atmosphere at the same level, and consequently, under these conditions, the buoyancy can never be great enough to produce a violent uprush. Nor, indeed, has a violent uprush of the atmosphere anywhere been detected, whether by kites, balloons, or otherwise, save within the mass of large cumulus clouds.

Von Bezold [1] suggests that the powerful movements, the puffing up and the pushing forth of new heads from a cumulus cloud, indicate that there is a source of power within the cloud itself. And this power he ascribes to the latent heat set free by the more or less sudden condensation of a supersaturated vapor or the sudden freezing of undercooled water drops.

Of course, as everyone will admit, the sudden condensation of a large amount of water throughout a great volume of supersaturated vapor would lead to an equally sudden and considerable expansion of the atmosphere; and the same fact, though on a lesser scale, applies to the sudden congelation of a great mass of undercooled water droplets. But then, as Von Bezold himself points out, it is not obvious just how or why such extensive condensations or freezings as the

[1] Sitzungsberichte Ber. Acad. 1892, p. 279.

movements of the larger cumulus clouds would require, if their movements were caused by these phenomena, can possibly take place.

Nor is it at all clear how any appreciable degree of supersaturation can obtain. Thus the initial rising atmosphere, coming as it does from near the ground, must contain an abundance of dust particles sufficient to induce condensation immediately that convection has brought the temperature to the dew point. This explains why it is that a number of individual cumulus clouds, simultaneously covering a limited region, have their bases all substantially at the same elevation, and why they so frequently assume the echelon or stair-step formation. Of course, we might assume that the reason why the bases have a common level is that in each cloud the same degree of supersaturation, however high, is reached in each rising column before saturation begins. But such a condition seems extremely improbable, and, if dust is present, simply impossible. Besides, the records obtained by kites and balloons, as they rise up beneath and into clouds, indicate that saturation does not obtain below the level of the cloud base. It would seem, too, that once condensation has set in, the cloud particles thus formed would serve as ample nuclei for any further condensation, so that supersaturation after initial condensation would be impossible.

On the whole, then, it appears most unlikely that supersaturation, at least to any appreciable degree, ever occurs in the formation of cumulus clouds, and that we must therefore look for some other cause of the vigorous uprush in their centers.

The accompanying diagram of vertical temperature gradients (fig. 1)—altitudes in kilometers, temperatures in degrees C.—will aid in the understanding of the phenomenon in question.

Assume, to be definite, a typical summer afternoon with the surface temperature 30° C. and the dew point 15° C. Let the free unsaturated air have the approximately average summer vertical temperature gradient of 6° C. per kilometer from an elevation of 7 or 8 kilometers down to 1½ kilometers, say, above the surface, as represented in the figure by the line F E D K C.

In the early morning, before convection began, the vertical temperature gradient of the lower kilometer and a half may have been somewhat as represented by the line C G. But whatever it was, as the surface became warmed convection gradually set in and slowly built up to increasing heights a temperature gradient approximately equal to the adiabatic gradient of dry air, or 10° C. per kilometer change in elevation. At no time, however, owing to the gradual development of this condition, could there be any great difference between the temperature of a rising column and that of the surrounding atmosphere at the same elevation, and therefore at no time or place a violent uprush.

When the surface temperature has reached 30° C., the gradient has become very nearly 10° C. per kilometer all the way from A to C. At the latter point, however, under the assumed conditions, condensation sets in, and the gradient abruptly changes to the adiabatic for saturated air, or, in this case, to rather less than 5° C. per kilometer. Hence, as the gradient for the free air is approximately 6° C. per kilometer, it follows that the temperature within the cloud must,

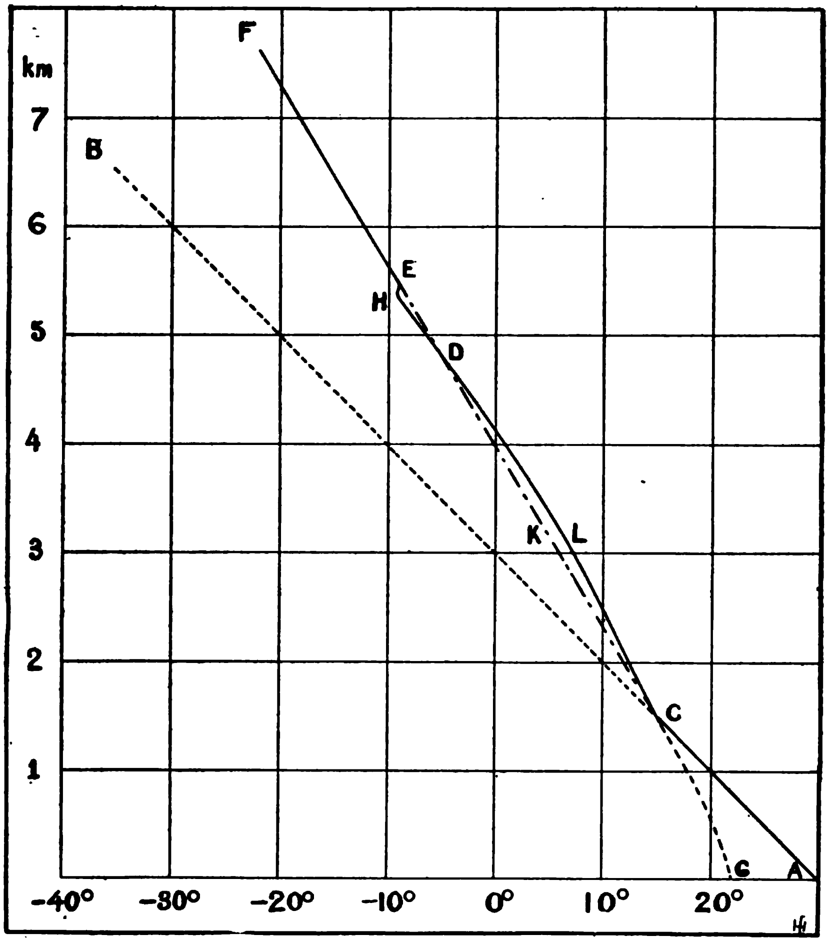

FIG. 1.—Vertical temperature gradients attending cumulus clouds.

for a considerable distance at least, become increasingly different from that of the surrounding atmosphere at the same level, and the buoyant force be correspondingly increased.

The difference in temperature, therefore, between the free air and the interior of large cumulus clouds at the same level seems to be the real cause of the violent uprush and turmoil in their centers.

As the rising air grows cooler, less and less moisture is condensed per degree drop of temperature, and hence the gradient within the cloud becomes more and more nearly the adiabatic gradient of a dry gas, and therefore at a certain elevation, at D, say, the temperature within the cloud falls to that of the adjacent free air, and the equilibrium level is reached. But the equilibrium level is not the maximum elevation of the cloud, since the momentum of the rising column carries it to some higher point, H, where through expansion it has become more or less undercooled, and from which point, therefore, being denser than the adjacent atmosphere, it must to some extent drop back to lower levels.

The gradient of the free air, then, from the level of the base of the cumulus cloud, may be represented by C K D E F, and the gradient in the cloud by C L D H E.

It may be recalled that the modern theory, as developed by Simpson,[1] of the cause of the great amount of electricity in thunderstorms, requires an uprush of the atmosphere sufficiently vigorous to split up, and thus electrify, the larger drops of rain.

The above discussion seems to be in full accord with this theory, since it shows that such an uprush must be the rule and not the exception in large cumulus clouds, with which indeed all or nearly all thunderstorms are associated.

Hence we may go one step further and say that most, at least, of the electrical and other energy of the thunderstorm comes directly or indirectly from the latent heat of condensation set free within the mass of turbulent cumulus clouds.

[1] Part 8, Vol. XX, Memoirs of the Indian Meteorological Department.

(XII) ATMOSPHERIC HUMIDITY AS RELATED TO HAZE, FOG, AND VISIBILITY AT BLUE HILL.

By ANDREW H. PALMER, A. M.

(Dated Nov. 30, 1912.)

On account of its location, both in respect to height above sea-level and distance from centers of civilization, and also because of the fact that unchanged methods of observation have been followed for more than 25 years, the records of Blue Hill Observatory offer a reliable basis for a study of haze, fog, and visibility. Situated 195 meters above the sea and 10 miles from the center of Boston, the observatory is the highest point of land within a distance of 25 miles, while the relatively level nature of the territory in the vicinity of the hill gives its summit a semifree-air exposure. The records of the observatory include observations of haze when it has occurred, continuous automatic records of humidity, and semidaily observations of visibility. In addition to these, the data obtained by means of kites include records of humidity at various heights in the free air.

Of the elements with which meteorology is concerned, water in its various forms is second in importance only to heat. Though usually invisible, the moisture of the atmosphere plays a most important part in natural economy. Next to the actual temperature its effect is greatest in the determination of what is known as "sensible temperature," that is, the temperature of the air as we feel it.

In the great mass of weather lore which has grown up as a result of observations made by men attempting to forecast the future weather conditions, the effects of changing humidity, next to changes in the appearance of the sky, probably form the most fruitful basis. The reason for this is that nearly all animate and many inanimate objects are affected more or less by changing humidity, and changing humidity usually is the forerunner of more general weather changes.

Vapor pressure, or absolute humidity, indicates the amount of water present in the air and forms the foundation for all comparisons of atmospheric humidity. Through a coincidence, for ordinary temperatures, vapor pressure expressed in millimeters is practically equivalent to the weight of water vapor in grams per cubic meter. It has been found that if the water vapor of the atmosphere were wholly condensed at any time, it would give a layer of water the depth of which would be the product of the vapor pressure, the specific gravity of mercury, 13.6, and a constant, 0.22.[1] The mean

vapor pressure at Blue Hill, as established by observations for the 20 years, 1886–1905, inclusive, is 7.1 millimeters. Substitution of this amount in the formula gives 21.2 millimeters as the depth of the water which would be precipitated by complete condensation under average conditions at Blue Hill. For July, when the mean vapor pressure is highest, 13.7 millimeters, the precipitation equivalent is 41 millimeters, while in January and February, when the mean vapor pressure is but 2.5 millimeters, it amounts to 7.5 millimeters. It is interesting to note that if the moisture in a fog bank extending from the 500-foot level to the 1,500-foot level on Mount Tamalpais, near San Francisco, should suddenly be precipitated it would give a rainfall of about 2.5 millimeters, according to one calculation.[3]

Table I, which is based upon the observations of the year 1909, gives the average vapor pressure associated with the winds from the various directions at Blue Hill. It is apparent that for all winds the vapor pressure is higher in summer than it is in winter, and that for most winds it is higher at 9 a. m. than at 2 p. m. in summer, while the reverse is true for winter, facts possibly explained by the diurnal and seasonal changes in temperature. Moreover, though the warmest wind at the observatory in summer is from the southwest and the coldest is from the northeast, the highest vapor pressure is associated with south winds and the lowest with winds from the opposite direction. In winter, when the warmest are from the south and the coldest from the northwest, the highest vapor pressures are still found with south winds, while the lowest then accompany northwest winds.

TABLE I.—*Average vapor pressure with various winds, expressed in millimeters.*

	N.	NE.	E.	SE.	S.	SW.	W.	NW.
Summer:	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
9 a. m.....	10.0	8.8	12.4	11.4	14.3	12.0	10.9	9.0
2 p. m.....	7.0	13.0	11.4	8.4	12.8	12.5	10.5	9.3
Winter:								
9 a. m.....	2.3	3.2	3.6	4.0	4.4	3.5	2.4	1.7
2 p. m.....	2.6	3.5	4.0	4.7	4.7	3.6	2.4	1.8

HAZE.

Haze in the sense used in this study refers to that condition in which the lower strata of the atmosphere contain a large number of very finely divided particles, each invisible in itself, but collectively producing an opaqueness which destroys the definition of distant objects. The individual particles consist of minute globules of water deposited upon invisible dust motes. At such a time the sun rises and sets

as a ruddy ball of fire, during the day the sky has a pale appearance, while at night the stars of lesser brightness are invisible, and those which are seen have a reddish tinge. Haze should not be confounded with the dark-brown cloud which hovers over every great city, nor with the smoke which rises from forest fires. Neither does the dust consist of coarse particles picked up by the wind, for it is made up of saline, sulphurous, and carbonaceous matter so finely divided as to be invisible, its presence being made known through its hygroscopic characteristics. As to the sources of these dust particles, John Aitken, who may be regarded as an authority upon the subject, says that they may arise from combustion, evaporation of the spray of salt water, electrical discharge, volcanoes, heating of matter in contact, and from meteoric sources.[3] That salt particles are always present in the atmosphere may be shown by the yellow color which can be produced in the flame-color test of the chemical laboratory. Dr. Carl Barus, who has made an extensive study of the dust content of jets, says: "I conclude * * * that the excessively fine dusty constituent of the air (i. e., those particles which give rise to colored cloud condensation, and are therefore virtually visible by interference methods) is a fixed attribute of normal atmospheric air, and is invariable as to quantity."[4] Again, Prof. Cleveland Abbe, says: "The dust and haze needed to produce red coloration of light by selective absorption and reflection are always present in the lowest air stratum."[5] From a meteorological point of view the vapor rather than the dust is the more important, but its presence would not be optically observable were it not for the dust upon which it collects. In haze the average size of the particles is such that their effect upon the mixed rays of sunlight is one of reflection rather than of selective absorption or of angular refraction.

It has been the custom at the observatory to record the occurrence of haze both in the morning and in the afternoon. Moreover, distinction has been made between two grades of density—(1) that of simple haze, (∞) when low objects 7 miles distant are visible, and (2) dense haze, (∞^2) that which is so thick that objects 7 miles away are invisible.

Table II shows the occurrence of haze as recorded at Blue Hill Observatory during a period of 20 years, 1890–1909, inclusive. It is apparent that haze is most frequent in the summer months, especially July and August, and is least frequent in the late winter and early spring. The difference in frequency from month to month is not great, however. Very dense haze is more common than only moderately dense haze. Though not shown in the table, haze occurs more frequently in the early morning than in the afternoon. As the sun rises the increasing insolation deepens the haze stratum, renewed convection stirs it up, and occasionally a cumulus cloud develops at the summit of an especially strong ascending current.[6] In a large

number of instances the vertical extent of the haze is but 100 to 200 meters above the general level of the country. The summit of Blue Hill frequently projects above the level surface forming the upper limit of the haze, and the upper part of Mount Wachusett, 44 miles distant, is plainly visible, while objects less than a mile from the base of the hill are wholly invisible. Such instances occur only in the early morning, before the ascending currents begin. The distinct plane of separation between haze and clear air is similar to that separating the base of a cumulus cloud from the transparent air below, the relative positions being inverted in the two cases, however.

TABLE II.—*Occurrence of haze.*

	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	Ave.
January—∞^2	0	0	2	10	14	4	7	10	4	3	9	7	9	13	10	5	12	13	11	10	7.7
∞	0	0	0	2	0	2	9	5	15	13	6	5	4	8	5	10	7	8	9	17	6.3
February—∞^2	2	2	4	3	5	5	2	9	13	3	4	5	8	8	5	8	8	10	5	12	6.1
∞	3	0	0	3	0	1	6	9	5	10	4	8	3	4	4	4	6	4	6	10	4.5
March—∞^2	3	3	3	5	9	5	1	8	13	5	5	7	12	11	5	12	7	10	11	7	7.0
∞	3	0	2	3	0	3	4	6	8	8	11	8	5	5	3	7	5	9	8	6	5.2
April—∞^2	3	3	5	5	8	8	14	6	3	6	1	7	8	7	6	9	5	7	7	9	6.4
∞	7	0	2	5	2	5	3	10	12	21	11	3	5	1	4	2	8	4	12	10	6.4
May—∞^2	5	5	4	10	7	7	16	10	7	9	9	9	9	10	6	7	7	11	7	9	8.2
∞	4	5	4	3	0	10	7	10	14	10	7	7	5	4	8	0	9	6	12	9	6.7
June—∞^2	5	6	9	9	10	6	8	7	7	1	6	9	3	3	8	10	11	17	12	11	7.9
∞	0	1	2	0	5	5	8	12	15	4	8	11	2	0	2	5	9	5	9	7	5.5
July—∞^2	9	2	7	6	14	12	15	13	9	1	7	13	8	4	11	5	18	16	14	6	9.5
∞	0	1	0	4	3	7	8	13	17	6	7	4	5	6	6	7	8	8	10	14	6.7
August—∞^2	1	12	5	5	12	11	14	3	10	10	9	13	8	6	10	15	15	15	12	10	9.8
∞	2	1	1	3	7	13	7	14	11	5	6	0	6	2	11	6	8	6	8	16	6.7
September—∞^2	5	9	1	7	13	13	8	7	6	3	11	13	12	8	7	8	14	8	23	2	8.9
∞	5	1	0	1	5	4	8	12	13	7	3	1	4	0	4	5	4	6	6	25	5.7
October—∞^2	6	5	5	8	7	9	9	13	3	11	4	9	8	7	5	9	15	15	17	8	8.7
∞	2	1	2	2	2	6	13	11	11	4	6	2	2	1	6	10	6	5	5	22	6.0
November—∞^2	8	0	2	9	5	10	9	4	4	8	5	6	18	11	13	11	11	18	13	9	8.7
∞	2	0	1	7	2	5	7	9	11	5	6	6	4	5	7	8	6	3	6	27	6.4
December—∞^2	5	7	2	6	6	3	13	3	2	4	8	10	10	8	12	11	11	15	16	15	8.4
∞	2	2	0	3	4	3	4	15	23	6	10	1	5	5	6	6	5	6	7	20	6.7
Year—∞^2	52	54	49	83	110	93	116	93	81	62	78	108	113	96	98	110	134	155	148	108	8.1
∞	30	12	14	36	30	64	84	126	155	99	85	56	50	41	66	70	81	70	98	183	6.1

Though water vapor is the essential constituent of haze, it is not necessarily present in a sufficient quantity to cause a high relative humidity, even in the densest haze. In fact the air is usually quite dry at this time, and the wind with which the haze is associated is not more humid than at times when no haze is formed. It has been suggested that haze usually occurs with dry weather because of the excess of fine particles at such a time, for in wet weather some of the minute particles are carried to the ground as nuclei of condensation. Moreover, in still weather a more than ordinary number aggregate in the lower levels, explaining the more frequent occurrence of haze then than at other times. It is probable that the formation of haze depends upon the form or the size of the water particles, rather than upon the amount of water vapor as indicated by the relative or the absolute humidity. Observations obtained by means of kites have shown that the air immediately above the summit of a cloud is warmer and drier than that of the surrounding air. Data obtained within

and above a stratum of haze show the presence of a similar temperature inversion. When the haze is limited to the lowest strata of the air the inversion is usually large. For example, when at 7 a. m. on February 16, 1911, the summit of Blue Hill projected above the haze stratum the temperature at the observatory was 7.6° F., whereas at the Valley Station, 177 meters lower, it was −20.7° F.

Basing his ideas upon laboratory experiments, Bidwell suggested that the occurrence of an opaque steam jet is due to electrical influences similar to those by which Lord Rayleigh produced a coalescence of scattering water jets, and therefore believed that the particles of an opaque jet to be larger than the corresponding particles in ordinary jets.[7] Helmholtz, however, later proved that the opaque jet has smaller particles than the ordinary jet. In the somewhat analogous cases of haze and fog the significance of electricity is not yet understood.

Haze may be regarded as an incipient or a vanishing fog, thus making haze, fog, mist, and rain simply different degrees of vapor density. Its relation to precipitation, as shown in Table III, is therefore interesting. This table is based upon the observations 10 years, 1900–1909, inclusive, a day with precipitation amounting to 0.01 inch or more having been called rainy. It is apparent that the day preceding the occurrence of haze is less frequently rainy than the average of all days without regard to haze. The day on which haze occurs has precipitation about as frequently as does the average day, while the day following the occurrence of haze is rainy about 50 per cent more often than the average for the year. It thus appears that haze is the forerunner of precipitation, for whereas 33 per cent of the days of the year are rainy, precipitation accompanies haze 80 per cent of the time, occurring either on the day with haze or on the first day following. This is a fact which may be used to advantage at times in weather forecasting.

TABLE III.—*Average frequency of precipitation associated with haze. Expressed in per cent.*

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
On day preceding haze	38	26	37	26	33	31	32	23	31	33	16	38	30
On day with haze	40	34	40	33	46	45	44	31	20	11	25	29	33
On day following haze	58	45	55	43	45	47	43	32	41	46	48	56	47
Average frequency, without regard to haze	35	25	42	33	45	50	39	39	33	16	27	19	33

In relation to the amount of precipitation the occurrence of haze is also worthy of study. Table IV, also based upon the observations of 10 years, 1900 to 1909, inclusive, shows that, whereas on the average the amount of precipitation on the day preceding the occur-

rence of haze is about normal, on the day of the appearance of haze is about half the normal, while that on the day following the observation of haze is almost twice the normal. As indicated in the case of frequency of precipitation, the occurrence of haze seems to be related to the transition period between fair weather and precipitation.

TABLE IV.—*The average amount of precipitation associated with haze (expressed in inches).*

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
On day preceding haze	0.11	0.09	0.17	0.10	0.06	0.10	0.11	0.09	0.15	0.08	0.06	0.10	0.10
On day with haze	.07	.06	.08	.05	.07	.08	.12	.06	.05	.02	.03	.03	.06
On day following haze	.20	.20	.23	.18	.14	.14	.18	.16	.18	.16	.18	.29	.19
Average daily precipitation	.16	.07	.09	.11	.05	.15	.07	.12	.21	.05	.07	.13	.11

The direction of the wind accompanying haze is shown in Table V, which is a summary of the observations of five years, 1900 to 1904, inclusive. The data, expressed in per cent, shows that haze occurs most frequently with southwest winds, and least frequently with east and southeast winds. The averages here attributed to north winds are probably higher than they ought to be, since the smoke then driven southward from Boston is sometimes mistaken for haze. The relatively high frequency with southwest winds may be related to the fact that these winds are usually warm and come from off the land, while the relatively infrequent occurrence with east and southeast winds may be the result of their being cool and from off the sea. Dense haze will sometimes vanish when the wind changes from a warm land to a cool sea breeze, while it will often form quickly when the change is in the opposite direction. An instance of the former is that of May 24, 1901, when the wind backed from south to northeast, while an example of the latter type occurred January 10, 1902, when the wind veered from southeast to northwest. Haze seems to be associated with a relatively stagnant condition of the atmosphere, as suggested by the averages included under variable winds, for its occurrence with moderately strong winds is infrequent. Occasionally haze will disappear when the wind velocity suddenly increases, and sometimes it forms quickly when the velocity diminishes to a relative calm.

TABLE V.—*Direction of the wind accompanying haze (expressed in per cent).*

	N.	NE.	E.	SE.	S.	SW.	W.	NW.	Variable.
January	22	2	2	1	9	16	30	11	7
February	17	2	0	0	12	17	33	15	4
March	11	11	2	0	9	27	10	6	24
April	12	14	2	2	23	13	10	6	18
May	0	19	1	1	21	18	11	11	18
June	6	10	0	0	13	26	14	8	23
July	1	5	3	0	22	29	19	4	17
August	8	12	1	1	23	15	22	1	17
September	12	11	1	1	22	18	9	8	18
October	6	6	0	2	16	28	20	8	14
November	21	5	0	0	7	23	20	18	6
December	23	5	0	3	3	31	17	11	7
Year	12	8	1	1	15	22	18	9	14

The relation between the occurrence of haze, precipitation, and wind velocity and direction suggests at once the location of the haze area in respect to cyclonic distribution. It occurs most often at the front of a cyclone, this being a region characterized by the light, warm, southerly winds preceding precipitation. This location of the region of most frequent haze agrees well with that of decreased visibility, a phenomenon to be referred to later. In general, the conditions which favor the formation of haze are (1) light south to west winds accompanied by falling pressure; (2) calm, cloudless weather with increased radiation and hence great diurnal ranges in temperature; and (3) light, variable winds, damp weather, nocturnal frosts, with snow covering the ground. Usually under these conditions haze forms over wide areas. Occasionally, however, when calm conditions allow the formation and persistence of an extremely heterogeneous atmospheric state, both in respect to temperature and to moisture, local haze develops.

The analogy between haze and fog is so close that studies of the latter have frequently contributed to our knowledge of the former. Prof. Alexander McAdie, in describing certain studies of fog made in the vicinity of San Francisco, said: "There was good reason for believing that the electrometer gave in certain fluctuations indications of the proximity of invisible vapor masses."[8] Absence of haze under such conditions may have been related to temperature conditions or to the dust content. Again he says: "The amount of moisture varies so much in different fogs that the terms 'wet' and 'dry' are used. * * * In a 'wet' fog the particles are apt to be larger than in a 'dry' one."[9] In like manner haze occurs with various degrees of relative humidity, and it is probable that in dense haze the individual particles are larger than those in thin haze. In investigating English fogs, Capt. Alfred Carpenter found that there is little change with height in the density of fog, and that there is an abrupt transition from fog to clear atmosphere—conditions which

are also true of haze.[10] Moreover, in a report on fog made by the English Meteorological Council it is stated that one of the prerequisite conditions in the formation of fog is that of little or no wind, a condition similar to that to which we have referred above in the case of haze.[11]

FOG.

Fog differs from haze principally in the size of the water particles, the relatively large size being due to (1) greater humidity, (2) a more sudden mixture of two masses of air of different temperature, or (3) a greater difference between the temperatures of the two masses. Unlike haze, it occurs only with saturated air. Fog is essentially a stratus cloud inclosing the observer, the state of the mass being one of incomplete condensation. Though radiation plays a more important part in the formation of fog, the causes of haze and fog are similar. As Prof. McAdie has pointed out, fog, like frost, may be considered to be largely a problem in air drainage.[12] It may be formed by (*a*) a mixture of two volumes of air differing in temperature, (*b*) by contact of air near its dew point with a cold surface or with a colder stratum of air and (*c*) radiation from nearly saturated air. When it occurs at the Blue Hill Observatory, fog is recorded each hour between 7 a. m. and 8 p. m. During 10 years, 1901 to 1910, inclusive, the percentage of the time between these hours during which fog occurred was found to be as follows:

Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
8.2	6.2	8.6	10.3	8.4	8.8	4.8	4.8	7.7	5.0	6.5	5.2	7.0

According to these averages fog is most common at Blue Hill during the spring, with the maximum occurring in April, while it is least common in the summer, the minimum coming in July and August.

With reference to their origin, by far the greater proportion of the fogs noted at the observatory are formed by mixture. This condition is usually that of a shallow, cool, easterly current from off the ocean superposed by a warm, moist wind, usually from a southerly point. Spring is therefore the period of most frequent fog because the air over the continent is then warmer than that over the sea, as the land warms more rapidly than the water. The southerly and westerly land breezes are then relatively warm as compared with sea breezes. The inversion of the usual temperature conditions is an essential characteristic of fogs formed in this manner. Increased convection causes a mixture in which the dew point is reached, causing fog. Whether or not fog forms depends upon the differences in temperature and humidity between the two volumes of air. When the east-

erly current is sufficiently shallow the summit of Blue Hill stands out above the upper surface of the fog, as it sometimes does above haze, no other objects then being visible except Mount Wachusett. This condition occurs most frequently in the early morning, and does not persist long, for after the sun gets sufficiently high the increased temperature of the ascending currents causes the fog to dissipate, forming fracto-stratus clouds which soon disappear. At other times, when fog envelops the observatory, kite flights show the presence of the warm current but a short distance above the summit of the hill. A typical instance of such a condition is that of March 24, 1903, when at the summit of Blue Hill (195 meters above sea level) the temperature at 3.46 p. m. was 47.5° F. and the wind was east-northeast. Nineteen minutes later at a height of 329 meters the temperature was 52.8° and the wind was southeast, while at 911 meters the temperature at 4.28 p. m. was 57.1° and the wind south-southwest. The fog which enveloped the hill throughout the flight did not extend more than about 200 meters above the summit, for the relative humidity, which was 100 at 310 meters, dropped to 67 at 476 meters, and was 64 at 911 meters. Similar conditions were recorded with fogs in the kite flights made May 27 and November 24, 1898.

Separate record is kept at the observatory of lowland fogs forming in the vicinity of the base of Blue Hill. These fogs, which are very superficial, are sometimes caused by contact of air near its dew point with the cold ground, but more commonly are caused by excessive radiation, under clear night skies, from the ground and the air adjacent to it. Marked inversions, sometimes exceeding 20° F. in 200 meters, accompany them. An example is that of October 18, 1910, when the temperature at 6 a. m. at the Valley Station, 18 meters above sea level, was 31.1° F., while the thermograph at the observatory, 195 meters above sea level, registered 52° F. Both the fog and the inversion disappeared soon after sunrise, the temperature in the lowland being 5° higher at 2 p. m. than at the summit of the hill. With the lowland fog of October 8, 1909, the inversion amounted to 19°, and with that of October 31, 1910, it was 20°.

In the 10 years, 1901 to 1910, inclusive, the average number of days for each month with which lowland fogs occurred in the vicinity of Blue Hill is shown in the following:

Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
0.6	0.2	0.3	0.2	0.5	1.4	2.0	2.9	4.8	5.5	2.1	0.9	1.8

Whether the cloud be well up in the air or in contact with the earth in the form of fog, an ever-present condition appears to be that of

instability. Just as clouds are always in a state of growth or decay, so fog is continuously forming and dissipating, for as soon as the mixing or the excessive radiation is stopped the fog disappears. As described in the case of haze, the water globules attached to the dust particles in fog are in a state of constant change.

In regard to the cyclonic condition with which fogs are usually observed at Blue Hill, the great majority are found at the front of an approaching cyclone whose center subsequently passes close to or a short distance south of the hill. In this region of the cyclone there is usually an easterly indraft of cold air, accompanied by a marked temperature inversion and occasionally by decided barometric oscillations.[13] When the depression is marked, the east or northeast current is strong and relatively deep and fog forms in the mixture with the warm southerly wind overlying it. The cloud then envelops the hill and considerable precipitation results. As the center passes out to sea the wind slowly backs and decreases in velocity, the fog persisting from one to three days until it is dried up or is blown to sea by a dry northwest wind. An extreme case of such a condition is that of April 20 to 25, 1901, when the fog persisted continuously throughout six days. Such prolonged fogs are restricted to coastal regions, for even two consecutive days of fog are rare in the interior of the continent. The sea breeze of summer does not produce a fog, as it is short lived and is not usually superposed by the warm and moist southerly current. The latter reason also explains its absence with those east and northeast winds caused by an anticyclone passing seaward from the maritime Provinces of Canada.

The other two classes of New England fogs, together considerably less frequent at Blue Hill than the kind formed by mixture, usually occur in anticyclones, where accelerated radiation produces a marked temperature inversion in the lower air, a shallow stratum adjacent to the ground cooling to its dew point, producing low-lying fog, which is usually of brief duration.

There is a very marked increase in the intensity of the water-vapor absorption lines in the solar spectrum upon the approach of a general storm.[14] In this case it is possible that the spectroscope detects the increased humidity, caused by the mixing of the various currents, before cloud or fog makes it visually apparent. On the other hand, the change in the lines at the approach of a local storm is less marked, and if it be a small unimportant one, the strength of the water-vapor lines may scarcely be affected at all. It is also worthy of note that during fog the air has an exceptionally high positive potential electrically, values double or triple that of the normal for the season. Moreover, usually large and frequent oscillations in the value of the gradient occur.[15]

The source of the moisture, which may subsequently appear in the form of cloud, is shown in a general way by the relative humidities of the various winds. Table VI is based upon all the records of wind direction and relative humidity made at 9 a. m., 2 p. m., and 8 p. m., during the year 1909, the data having been separated for the four seasons. From the table, it is apparent that in winter and in spring north to east winds are relatively moist, while south to west winds are correspondingly dry. In summer and in autumn east to south winds are moist, while west to north winds are dry. Only the relative humidity is here referred to, for the winds also differ greatly from each other in temperature, and hence in absolute humidity. However, because of the importance of relative humidity in determining one's feeling of air temperature, the table may be of value in the proposed forecasting of "sensible temperatures." Not only is one's sensibility to extremes of temperature greatly influenced by the relative humidity, but a change of temperature is also felt more readily when the relative humidity is high than when it is low.

TABLE VI.—*Average relative humidity of the various winds.*

Wind direction.	9 a. m.				2 p. m.				8 p. m.			
	Spring.	Summer.	Autumn.	Winter.	Spring.	Summer.	Autumn.	Winter.	Spring.	Summer.	Autumn.	Winter.
N..........	84	67	81	85	88	50	63	81	69	50	83	87
NE..........	79	58	86	96	76	50	75	90	94	92	88	95
E..........	78	83	92	88	73	79	88	80	89	77	96	89
SE..........	73	71	89	82	69	55	69	74	86	73	92	89
S..........	70	81	91	91	61	60	72	81	82	77	88	86
SW..........	75	66	75	79	54	56	60	63	67	75	76	73
W..........	61	64	67	72	35	45	56	54	59	68	72	63
NW..........	54	58	65	63	38	49	57	46	49	64	60	59

In order to determine the average relative humidity of the winds aloft, all the records of humidity obtained up to 1911 by means of kites at Blue Hill Observatory were summarized in Table VII. From this table it is evident that both in summer and in winter easterly winds are relatively moist throughout, though they rarely persist above 2,000 meters. Winds from all other directions show a decrease in their relative humidities with increase of height, this increase being especially rapid above 2,000 meters. These observations agree well with Dr. J. Hann's conclusion that absolute humidity (vapor pressure) diminishes in a more rapid ratio with altitude than would be the case in an independent atmosphere of vapor subject to its own pressure only.[16] According to his formula, one-half of the aqueous vapor is below 1,962 meters (6,043 feet), and nine-tenths is below 6,500 meters (20,000 feet). Above the plane where the permanent upper inversion begins the vapor pressure must be very low, owing to the

low temperature of the air, but it is probable that even the small amount of water vapor present is important on account of its power of absorbing radiant heat.

TABLE VII.—*The average relative humidity of the various winds in the free air.*

Wind direction.	Summer.								Winter.							
	200 to 500	500 to 1,000	1,000 to 1,500	1,500 to 2,000	2,000 to 2,500	2,500 to 3,000	3,000 to 3,500	3,500 to 4,000	200 to 500	500 to 1,000	1,000 to 1,500	1,500 to 2,000	2,000 to 2,500	2,500 to 3,000	3,000 to 3,500	3,500 to 4,000
N	60	59	64	63	74	63	.....	.....	67	61	38	32	.....	.....	.....	.....
NE	81	79	71	70	68	40	38	37	71	81	86	61	.....	.....	.....	.....
E	79	71	94	.....	.....	.....	.....	.....	97	85	84	95	92	.....	.....	.....
SE	70	74	71	71	.....	.....	.....	.....	87	90	84	95	95	.....	.....	.....
S	74	78	61	62	53	.....	.....	.....	74	78	72	80	78	.....	.....	.....
SW	67	68	65	66	65	58	67	53	56	63	60	57	63	70	68	.....
W	53	61	64	58	56	56	46	.....	53	57	63	50	45	44	51	46
NW	61	63	66	58	54	48	32	23	57	63	72	53	47	43	33	41

The humidity of the free air is subject to greater and more sudden changes than is the temperature. This is especially marked in the vicinity of clouds. For example, at 1.45 p. m. on April 5, 1906, the relative humidity at 1,831 meters was 100, whereas at 2,029 meters it was but 20, only 4 minutes later. Even when a volume of air is not sufficiently saturated to produce a cloud the same condition is found. An instance is that of September 5, 1899, when at 2.41 p. m. the relative humidity at 2,097 meters was 99, whereas 10 minutes later at a height of 2,428 meters it had fallen to 19. Surprisingly low relative humidities are occasionally encountered; for example, that of September 20, 1900, 10.47 a. m., when at 1,857 meters it was but 1, with a temperature of 49.0° F.

The diurnal and annual periods in the humidity of the free air up to 4 kilometers were studied in an earlier research made at the observatory, and were, therefore, not reconsidered here.

VISIBILITY.

The transparency of the atmosphere is so closely dependent upon its humidity that it may properly be considered in this connection. The smoke arising from cities or from forest fires and the coarse dust blown up by the wind during dry periods do, of course, affect visibility greatly, but as they do not form constituent parts of the atmosphere itself they are essentially irrelevant. Of the physical changes which occur within the air, that of variation in the amount of water vapor is the most important, as far as visibility is concerned. From his studies of atmospheric dust Aitken concluded that the limit of visibility increases as the air gets drier, being dependent upon (1) the degree of saturation of the air, (2) the number of dust particles present, and (3) to some degree upon the vapor pressure, that is, the absolute as well as the relative humidity.[17]

At Blue Hill Observatory record is made twice each day of the general visibility of the atmosphere, a scale equivalent of 1 to 10, inclusive, being used. The following is a summary of these observations during the period of five years, 1905 to 1909, inclusive, and shows the mean monthly visibility in values of the scale mentioned:

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
9 a. m.	2	3	3	4	2	2	2	2	2	3	2	2	2.4
2 p. m.	3	4	4	4	4	3	3	3	3	4	4	3	3.5
Average	2.5	3.5	3.5	4.0	3.0	2.5	2.5	2.5	2.5	3.5	3.0	2.5	3.0

As might be expected from the fact that the sun is higher, the mean visibility is greater at 2 p. m. than at 9 a. m. Spring and autumn have a higher degree of visibility than summer and winter, April having the highest for the various months. The coarse dust and the smoke of summer and the dense haze and fog of winter probably account for the diminished visibility during these seasons.

Table VIII, based upon the same data as that included in the preceding summary, shows the mean visibility for winds from each direction. It is evident that the winds of least visibility, both at 9 a. m. and at 2 p. m., are from the southeast and south. Explained in terms of their moisture content it may be said that these are warm, moisture-laden winds which are cooling as they advance, resulting in an increased relative humidity and a corresponding decrease in transparency. On the other hand, winds from the northwest and north are the clearest of all, both in the morning and in the afternoon. Not only are they relatively dry, but they are also relatively cool, thus having low absolute humidities as well. As the smoke of Boston pollutes only the air immediately above and to the leeward of the city, it affects the general visibility at Blue Hill only when the wind direction is northerly.

Of the conditions with which the highest degree of visibility is most frequently associated at Blue Hill, the following are the more common: (1) North to west winds at the rear of a retreating cyclone or at the front of an approaching anticyclone. Usually at such times the air has just been washed of its foreign particles by precipitation, the coarse dust is held temporarily to the ground, and the cool northwesterly winds are relatively dry. Showers in summer and snow flurries in winter frequently accompany these conditions. (2) The calm and stagnant conditions occurring near the center of an anticyclone, especially in winter. With these conditions the sky usually is clear, the air dry, the temperature decreases regularly with increase of height, and the weather in general is fair. If, under these conditions, haze or fog does form, it is likely to be very shallow, and limited to the lowlands. (3) With northeast to southeast winds

which precede a period of bad weather. As shown in Table V, haze is least frequent with these winds. Frequently, under such conditions, the approach of the storm is already heralded by an overcast sky, the clouds being either cirro-stratus or altostratus. The transmission of light, as well as sound, is favored by an equalization of atmospheric conditions, and occasionally, as with the winds here described, the favorable effects of increased homogeneity are greater than the unfavorable effects of increased humidity.

The extreme clearness of the air observed with the foehn wind in Switzerland may be due partly to the homogeneous character of the atmosphere and partly to its reduced relative humidity (caused by the increased temperature) at the time.

Visibility having been investigated in its relation to atmospheric pressure and to temperature departures in an earlier study at the observatory, these factors were not reconsidered here.

TABLE VIII.—*Mean visibility for winds from each direction—Scale of 1-10, inclusive.*

Month.	9 a. m.								2 p. m.							
	N.	NE.	E.	SE.	S.	SW.	W.	NW.	N.	NE.	E.	SE.	S.	SW.	W.	NW.
January	2	1	2	1	1	2	3	4	1	1	1	1	2	2	4	6
February	2	1	1	1	1	1	4	4	4	2	2	1	1	2	4	7
March	2	1	2	1	1	2	4	5	3	2	2	1	2	2	5	7
April	3	1	2	1	2	2	4	6	3	3	2	3	2	2	4	8
May	3	2	2	2	2	2	4	6	5	2	2	3	2	2	6	7
June	2	2	2	1	2	2	3	4	2	2	2	3	2	2	5	6
July	4	1	1	2	1	2	3	5	3	2	2	2	2	2	5	7
August	2	2	2	1	1	1	2	4	3	3	3	3	1	2	4	6
September	2	1	1	1	1	2	2	5	3	3	2	2	2	3	4	3
October	2	2	1	1	1	2	3	5	1	2	2	2	3	2	5	7
November	2	1	1	1	1	1	3	3	3	1	2	1	1	2	4	6
December	2	1	1	1	1	1	2	4	2	1	2	1	2	2	4	6
Average	2.3	1.3	1.5	1.2	1.3	1.7	3.1	4.6	2.8	2.0	2.0	1.9	1.8	2.1	4.5	6.3

SUMMARY.

The water vapor of the atmosphere, next to the actual temperature, is the most important factor in the determination of the "sensible temperature." On Blue Hill the absolute humidity, or vapor pressure, is higher in summer than in winter, in the average, and it is higher at 9 a. m. than at 2 p. m. in summer, while the reverse is true during winter. Throughout the year, southerly winds have the highest, and northerly winds the lowest, average vapor pressures.

Haze, a condition in which minute water globules are deposited upon the ever-present but invisible dust particles, obscures the definition of distant objects. It is usually superficial, sometimes not extending as high as the observatory, and during the early morning a marked temperature inversion is a common accompaniment. It is most frequent in summer, and least frequent in winter, and it is more common in the morning than in the afternoon. Though the

essential constituent of haze is the water vapor, it is not necessarily present in a quantity sufficient to cause a high relative humidity, the formation of haze depending more upon the form or the size of the water particles than upon their number. In many ways haze may be regarded as an incipient fog preceding relatively heavy precipitation, as it occurs most frequently with the light, warm, southwesterly or southerly winds at the front of a cyclone.

Fog occurs only with saturated air, the condition being one of incomplete condensation. It may be caused by (*a*) a mixture of two volumes of air differing in temperature, (*b*) contact of air near its dew point with a cold surface or with a colder stratum of air, and (*c*) radiation from nearly saturated air. On Blue Hill it is most common in April and least common in July and August. With regard to origin, the kind most frequent is that formed from a mixture of a shallow, cool, easterly breeze with a warm, moist southerly or southwesterly current overlying it. The characteristic temperature inversion comes as low as the summit of the hill in shallow fogs, and has been recorded aloft by means of kites in the deeper ones. Low land fogs, formed either by contact or by radiation, are also accompanied by marked temperature inversions. The greater proportion of fogs are found at the front of a cyclone whose center subsequently passes close to, or a short distance south of, the hill. With reference to relative humidity, north to east winds are moist in winter and in spring, while south to west winds are correspondingly dry. During the other half of the year east to south winds are moist, while west to north winds are dry. Both in winter and in summer easterly winds are relatively moist throughout, though they usually do not persist above 2,000 meters. Winds from the other directions decrease in relative humidity with height, on the average.

As far as visibility is concerned, the change in the vapor content is the most effective of the physical changes occurring within the atmosphere. Aitken concluded that visibility depends upon (1) the degree of saturation of the air, (2) the number of dust particles present, and (3) the vapor pressure. On Blue Hill the visibility is greatest, on the average, in the early spring, and is least during summer. Moreover, the air is usually clearer at 2 p. m. than at 9 a. m. Visibility is least with southeast and south winds, and is greatest with northwest and west winds, facts almost wholly dependent upon the differences in the moisture content of the various winds. Visibility is greatest with (1) north to west winds at the rear of a cyclone or at the front of an anticyclone, (2) the calm, stagnant condition occurring near the center of an anticyclone, especially in winter, and (3) northeast to southeast winds which precede marked changes in the weather.

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(XIII) FREE AIR DATA AT MOUNT WEATHER, VA., FOR JULY, AUGUST, AND SEPTEMBER, 1912.

By the Aerial Section, WM. R. BLAIR, in charge.

(Dated Dec. 21, 1912.)

During the three months, 62 free air observations were made. Fifty-nine of these were by means of kites and 3 by means of captive balloons. With the exception of international days, the observations of these three months were made in series, or in attempts at series, covering periods of 24 or more hours. The average altitude reached, all observations considered, was 3.1 kilometers, while the average altitude reached in complete series of ascensions was 3.6 kilometers. An effort was made in these series of ascensions to reach a uniform altitude of 3.5 kilometers above sea level.

While daily free air observations were in progress it became apparent that in some respects they were meteorologically far apart, and that for their comparison and interpretation a record of the changes occurring between them would be of great interest. Consequently, when it became necessary to discontinue the daily observations, series of observations extending over 24 or more hours were begun, as meteorological conditions permitted; the latter in the hope that the normal diurnal changes at all levels up to 3.5 kilometers in the meteorological elements observed might be obtained for different seasons and for different meteorological conditions. It is planned to continue these observations in 24 or more hour series for a year before summarizing them. In the meantine the data obtained in each quarter year is being reduced and published.

In this current publication of the data the tables of the individual observations contain all the data obtained just as it is reduced from the meteorograms. Pressure in millimeters, temperature in degrees centigrade, humidity (both relative in per cent, and absolute in grams per cubic meter), wind direction and velocity in meters per second, and the potential difference between the kite and the earth in volts, are shown at the times and altitudes of their observation. The surface pressure, temperature, relative humidity, and wind direction and velocity are shown for the same times.

The air pressures appear in the tables only. The temperatures are charted to show the free air isotherms for each series, and also to show the diurnal range in temperature at the different levels reached. Tables accompany the charts. The absolute humidities are charted and tabulated, as are the air temperatures. Wind velocities at the

different levels are charted, but not corrected for the 24-hour change. The wind directions are marked on the charts of wind velocities as often as changes in these directions occur. Atmospheric electric potentials are charted, but not corrected for the 24-hour change.

The above plan of current publication has been adopted because it is thought that the diurnal changes in temperature and absolute humidity at the different levels may be of current interest. The observations of these two elements have, therefore been corrected as well as possible, at each level considered, for the 24-hour changes in them, and the resulting data have been smoothed by comparing the data at the hours immediately before and after with that at the hour under consideration. Diurnal changes in these elements, but more especially in the other elements observed, will it seems, be more profitably considered in detail when more data have been obtained.

A series of observations begun between 6 and 7 a. m. July 19, 1912, had to terminate between 8 and 9 p. m. of the same day because the wind failed, first aloft and later at the lower levels. Figure 1 shows the free air isotherms for this series of observations. In order to understand the peculiarities of the temperature distribution shown in figure 1, or indeed in any of the following charts of free air isotherms, one must consult all the tabulated data of the series for which the chart is made, and especially the cloud notes accompanying the tables. For example, from 6 to 9 a. m., cumulus clouds, base 1 kilometer above sea level, were present. The rate of decrease of temperature with altitude is about the adiabatic for dry air up to the base of the cloud layer. In the cloud layer the temperature gradient is small or inverted, and well above the layer a regular fall of about 0.6° C. per 100 meters obtains. Other similar peculiarities in the positions of the isotherms may be found in figure 1 and in figures 2a, b, 9a, b, 14a, b, 18, and 19a, b, each of which shows the free air temperature distribution observed in a series of kite flights. Charts of free air isotherms have been made for all series of observations continuing 12 or more hours. The data obtained in series of shorter duration appear in the tables of individual observations only.

A not very serious fault with the observations of temperature charted in figures 2, 9, 14, 18, and 19 is apparent from a glance at the isotherms. The temperature element of the meteorograph in use is a pair of silver-plated, steel tubes which contain alcohol. It was found on examination that the steel had rusted not only in places exposed by some injury to the silver plate, but well under the plating. The presence of the rust, a comparatively poor conductor of heat, rendered the otherwise very sensitive element sluggish. Unfortunately this change in the element was taking place at a time when the work of computing was behind. It was therefore not detected until

several series of observations had been made with the sluggish element.

It is to eliminate the peculiarities which owe their existence to small clouds and to the above instrumental defect that the temperature curves shown in figures 3, 5, 10, 15, and 20 and in the curves of absolute humidity shown in figures 4, 6, 11, and 16 have been smoothed. In Tables I to IX the departures shown are the departures of the smoothed values from the mean value for the day at the level considered.

The series of July 26, 27, and 28 lasted about 42 hours, nearly twice the 24-hour period. July 26 was partly cloudy, while the 27th was clear. Two 24-hour periods have therefore been considered. These periods overlap from midnight to 10 a. m. of the 27th. In the first 24 hours the daytime is partly cloudy, the night following clear. The second period is all clear.

Figure 20 and Table IX are complete up to the 2-kilometer level only. This series of ascensions had to be finished with captive balloons. The two balloon ascensions were to an altitude of 2 kilometers. Unless the observations extend well over the 24-hour period, the correction for the 24-hour change can not well be made. The partial curves drawn in figure 20 at the 2.5 and 3 kilometer levels are, therefore, smoothed but not corrected for the 24-hour change. The balloon meteorograph did not carry a hygrometer. The curves of absolute humidity in figure 21 are, therefore, neither corrected nor smoothed.

The curves in figures 7, 12, 17, and 22 show the variation in wind velocity at different levels during the period of observation. Each figure represents the wind data of one series. These curves are drawn directly from the data found in the tables of the individual observations. Figures 8, 13, and 23 show the variation in atmospheric electric potential at different levels during the period of observation. Each figure represents a series, and all complete series are represented except that of August 19 and 20. During this series the potential difference between the kite and the earth was always less than 170 volts, the value of the first scale division of the voltmeter.

Three 24 or more hour series of observations have been published in Volume IV, parts 5 and 6, and in Volume V, part 1, of this bulletin. The five series now under consideration have been made in greater variety of weather conditions than the first three. It is extremely interesting, however, to note a similarity in the diurnal variations of the different elements observed.

The possibility of the existence of interesting relations between soil and free air temperatures in connection with the study of the diurnal range of temperature and other elements in the free air has

led to the installation of two soil thermographs (all that were available at the time) at Mount Weather on July 3, 1912. One of these instruments records temperatures at 2 centimeters, the other at 20 centimeters below the surface. Grass and weeds at the place of exposure of the thermometers are kept cut with a lawn mower. Table X shows the mean of the hourly temperatures taken from the record of these thermographs for July and August, 1912, also the hourly temperatures recorded on the days when series of observations in the free air were in progress. Under each heading the first column is derived from the record of the thermometer at 2 centimeters depth, the second from the record of the thermometer at 20 centimeters depth.

TABLE I.—*Free air temperatures at Mount Weather, July 26–27, 1912.*

Hour.	526 m. (surface).			1,000 m.			1,500 m.			2,000 m.			2,500 m.			3,000 m.		
	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departure.
	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.
1 a. m.	15.8	15.7	−2.0	13.7	13.3	−0.7	10.0	9.9	−0.7	8.1	8.2	−0.1	5.3	5.9	−0.5	3.7	3.8	−0.8
2 a. m.	15.2	15.3	−2.4	13.0	13.2	−0.8	10.5	10.1	−0.5	8.8	8.7	+0.4	5.5	6.1	−0.3	3.5	3.6	−1.0
3 a. m.	15.0	15.0	−2.7	12.9	13.4	−0.6	9.9	10.9	+0.3	9.1	9.6	+1.3	7.4	6.9	+0.5	3.5	3.5	−1.1
4 a. m.	14.8	14.9	−2.8	14.4	13.9	−0.1	12.2	11.6	+1.0	10.8	10.2	+1.9	7.7	7.5	+1.1	3.4	3.6	−1.0
5 a. m.	14.9	14.9	−2.8	14.3	14.1	+0.1	12.7	11.8	+1.2	10.8	10.1	+1.8	7.5	7.2	+0.8	3.9	3.8	−0.8
6 a. m.	15.1	15.3	−2.4	13.6	13.5	−0.5	10.6	10.8	+0.2	8.7	8.7	+0.4	6.5	6.3	−0.1	4.1	4.0	−0.6
7 a. m.	15.9	15.9	−1.8	12.5	13.0	−1.0	9.1	9.9	−0.7	6.6	7.8	−0.5	5.0	5.7	−0.7	3.9	4.1	−0.5
8 a. m.	16.7	16.7	−1.0	12.8	13.2	−0.8	10.1	10.4	−0.2	8.2	8.1	−0.2	5.6	6.1	−0.3	4.2	4.7	+0.1
9 a. m.	17.5	17.7	0.0	14.2	13.4	−0.6	11.9	10.5	−0.1	9.5	8.5	+0.2	7.6	6.7	+0.3	6.1	5.4	+0.8
10 a. m.	18.8	18.4	+0.7	13.2	13.2	−0.8	9.4	10.0	−0.6	7.7	7.9	−0.4	6.9	7.2	+0.8	5.8	5.7	+1.1
11 a. m.	19.0	19.3	+1.6	12.1	12.9	−1.1	8.8	9.4	−1.2	6.9	7.7	−0.6	7.0	7.2	+0.8	5.2	5.3	+0.7
12 noon	20.1	19.6	+1.9	13.5	13.8	−0.2	9.9	10.1	−0.5	8.5	8.5	+0.2	7.7	7.6	+1.2	4.9	4.9	+0.3
1 p. m.	19.7	20.2	+2.5	15.7	15.0	+1.0	11.6	11.3	+0.7	10.2	9.6	+1.3	8.0	7.9	+1.5	4.5	5.1	+0.5
2 p. m.	20.8	20.3	+2.6	15.9	15.4	+1.4	12.4	11.3	+0.7	10.0	9.2	+0.9	7.9	7.1	+0.7	5.8	5.1	+0.5
3 p. m.	20.4	20.4	+2.7	14.5	14.7	+0.7	10.0	10.7	+0.1	7.4	8.1	−0.2	5.3	6.0	−0.4	5.1	4.7	+0.1
4 p. m.	19.9	20.3	+2.6	13.7	14.6	+0.6	9.6	10.7	+0.1	6.9	7.7	−0.6	4.7	5.5	−0.9	3.3	4.7	+0
5 p. m.	20.6	20.2	+2.5	15.6	15.1	+1.1	12.4	11.5	+0.9	8.8	8.4	+0.1	6.5	6.5	+0.1	5.7	5.4	+0.
6 p. m.	20.0	19.8	+2.1	16.0	15.4	+1.4	12.5	11.9	+1.3	9.4	8.4	+0.1	8.2	6.8	+0.4	7.1	6.0	+1.4
7 p. m.	18.8	18.8	+1.1	14.6	14.8	+0.8	10.9	11.0	+0.4	7.1	7.8	−0.5	5.6	5.9	−0.5	5.1	5.2	+0.6
8 p. m.	17.6	17.9	+0.2	13.8	14.5	+0.5	9.6	10.5	−0.1	6.8	7.1	−1.2	3.9	4.5	−1.9	3.4	3.9	−0.7
9 p. m.	17.2	17.3	−0.4	15.0	14.5	+0.5	11.1	10.5	−0.1	7.3	7.0	−1.3	4.0	4.4	−2.0	3.1	4.0	−0.6
10 p. m.	17.2	17.0	−0.7	14.7	14.4	+0.4	10.7	10.4	−0.2	7.0	7.0	−1.3	5.3	5.2	−1.2	5.4	4.5	−0.1
11 p. m.	16.6	16.7	−1.0	13.5	13.8	−0.2	9.4	9.8	−0.8	6.7	7.2	−1.1	6.4	6.2	−0.2	4.9	4.9	+0.3
12 midnight	16.2	16.2	−1.5	13.2	13.5	−0.5	9.2	9.7	−0.9	7.8	7.5	−0.8	7.0	6.2	−0.2	4.3	4.3	−0.3
Means	17.7	....	.....	14.0	....	.....	10.6	....	.....	8.3	....	.....	6.4	....	.....	4.6	....	.....

TABLE II.—*Absolute humidities at Mount Weather, July 26–27, 1912.*

Hour.	526 m. (surface).			1,000 m.			1,500 m.		
	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.
	g/cu. m.	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*
1 a. m.	12.0	11.9	+0.1	9.5	9.2	−0.3	6.8	6.7	−0.4
2 a. m.	11.9	11.9	+0.1	10.1	9.9	+0.4	6.6	6.6	−0.5
3 a. m.	11.9	11.9	+0.1	10.2	9.9	+0.4	6.4	6.4	−0.7
4 a. m.	11.8	11.7	−0.1	9.5	9.7	+0.2	6.3	6.4	−0.7
5 a. m.	11.4	11.5	−0.3	9.3	9.4	−0.1	6.6	6.6	−0.5
6 a. m.	11.4	11.4	−0.4	9.3	9.4	−0.1	6.9	6.9	−0.2
7 a. m.	11.4	11.4	−0.4	9.7	9.7	+0.2	7.2	7.2	+0.1
8 a. m.	11.5	11.6	−0.2	10.0	9.8	+0.3	7.4	7.3	+0.2
9 a. m.	11.9	11.4	−0.4	9.6	9.3	−0.2	7.3	7.0	−0.1
10 a. m.	10.8	11.2	−0.6	8.3	8.6	−0.9	6.3	6.4	−0.7
11 a. m.	11.0	11.1	−0.7	7.9	8.3	−1.2	5.6	6.2	−0.9
12 noon.	11.5	11.3	−0.5	8.8	8.8	−0.7	6.6	6.6	−0.5
1 p. m.	11.3	11.4	−0.4	9.6	9.4	−0.1	7.5	7.1	0.0
2 p. m.	11.5	11.6	−0.2	9.7	9.6	+0.1	7.2	7.2	+0.1
3 p. m.	11.9	11.7	−0.1	9.4	9.5	0.0	6.8	7.0	−0.1
4 p. m.	11.7	11.8	0.0	9.3	9.7	+0.2	6.9	7.2	+0.1
5 p. m.	11.7	11.8	0.0	10.3	10.1	+0.6	8.0	7.6	+0.5
6 p. m.	12.1	12.1	+0.3	10.7	10.4	+0.9	7.9	7.7	+0.6
7 p. m.	12.4	12.3	+0.5	10.3	10.3	+0.8	7.2	7.5	+0.4
8 p. m.	12.5	12.3	+0.5	9.9	10.2	+0.7	7.5	7.7	+0.6
9 p. m.	12.1	12.2	+0.4	10.3	10.1	+0.6	8.5	8.1	+1.0
10 p. m.	11.9	12.1	+0.3	10.2	9.7	+0.2	8.4	8.1	+1.0
11 p. m.	12.2	12.0	+0.2	8.6	9.0	−0.5	7.4	7.5	+0.4
12 midnight.	11.9	12.0	+0.2	8.1	8.7	−0.8	6.8	7.0	−0.1
Means.	11.8	....	....	9.5	....	....	7.1	....	....

Hour.	2,000 m.			2,500 m.			3,000 m.		
	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.
	g/cu. m.	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*
1 a. m.	4.0	3.8	−1.2	3.1	3.0	−0.8	2.8	2.7	+0.2
1 a. m.	4.3	3.8	−1.2	3.3	3.1	−0.7	2.6	2.6	+0.1
3 a. m.	3.2	3.7	−1.3	2.9	3.1	−0.7	2.4	2.7	+0.2
4 a. m.	3.5	3.6	−1.4	3.2	3.2	−0.6	3.0	3.1	+0.6
5 a. m.	4.2	3.9	−1.1	3.5	3.3	−0.5	3.8	3.3	+0.8
6 a. m.	4.1	4.2	−0.8	3.2	3.3	−0.5	3.2	3.2	+0.7
7 a. m.	4.2	4.7	−0.3	3.3	3.6	−0.2	2.6	2.8	+0.3
8 a. m.	5.7	5.3	+0.3	4.4	4.2	+0.4	2.6	2.6	+0.1
9 a. m.	6.1	5.4	+0.4	5.0	4.4	+0.6	2.7	2.6	+0.1
10 a. m.	4.5	4.9	−0.1	3.8	4.0	+0.2	2.6	2.5	0.0
11 a. m.	4.0	4.3	−0.7	3.1	3.4	−0.4	2.3	2.4	−0.1
12 noon.	4.3	4.4	−0.6	3.3	3.4	−0.4	2.4	2.6	+0.1
1 p. m.	4.9	4.9	−0.1	3.7	3.6	−0.2	3.2	2.8	+0.3
2 p. m.	5.5	5.4	+0.4	3.9	3.8	0.0	2.9	2.7	+0.2
3 p. m.	5.8	5.8	+0.8	3.9	4.0	+0.2	1.9	2.3	−0.2
4 p. m.	6.1	6.1	+1.1	4.1	4.2	+0.4	2.1	2.2	−0.3
5 p. m.	6.5	6.4	+1.4	4.5	4.3	+0.5	2.6	2.5	0.0
6 p. m.	6.5	6.4	+1.4	4.4	4.2	+0.4	2.9	2.6	+0.1
7 p. m.	6.2	6.2	+1.2	3.6	4.0	+0.2	2.2	2.2	−0.3
8 p. m.	6.0	6.4	+1.4	4.1	4.3	+0.5	1.4	1.6	−0.9
9 p. m.	6.9	6.4	+1.4	5.3	4.8	+1.0	1.1	1.3	−1.2
10 p. m.	6.4	5.6	+0.6	5.3	4.6	+0.8	1.4	1.5	−1.0
11 p. m.	3.5	4.3	−0.7	3.1	3.7	−0.1	2.0	2.0	−0.5
12 midnight.	3.1	3.5	−1.5	2.7	3.0	−0.8	2.6	2.5	0.0
Means.	5.0	....	....	3.8	....	....	2.5	....	....

TABLE III.—*Free air temperatures at Mount Weather, July 27, 1912.*

Hour.	526 m. (surface).			1,000 m.			1,500 m.			2,000 m.			2,500 m.			3,000 m.		
	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.
	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.
1 a. m.	16.2	16.3	−2.2	14.8	14.6	−0.3	11.9	12.1	+0.2	10.5	10.8	+0.4	7.3	7.9	−0.7	5.2	5.2	−0.9
2 a. m.	15.6	15.7	−2.8	14.0	14.2	−0.7	12.3	11.9	0.0	11.1	10.9	+0.5	7.5	8.0	−0.6	5.0	5.1	−1.0
3 a. m.	15.3	15.3	−3.2	13.8	14.3	−0.6	11.6	12.6	+0.7	11.2	11.7	+1.3	9.3	8.8	+0.2	5.0	5.0	−1.1
4 a. m.	15.1	15.1	−3.4	15.2	14.6	−0.3	13.8	13.2	+1.3	12.9	12.3	+1.9	9.5	9.3	+0.7	4.9	5.1	−1.0
5 a. m.	15.0	15.1	−3.4	14.9	14.7	−0.2	14.2	13.3	+1.4	12.8	12.1	+1.7	9.2	8.9	+0.3	5.3	5.2	−0.9
6 a. m.	15.2	15.4	−3.1	14.1	14.1	−0.8	12.0	12.2	+0.3	10.5	10.5	+0.1	8.1	8.0	−0.6	5.4	5.3	−0.8
7 a. m.	16.0	16.0	−2.5	13.4	13.5	−1.4	10.4	11.2	−0.7	8.3	9.5	−0.9	6.6	7.3	−1.3	5.2	5.4	−0.7
8 a. m.	16.7	16.7	−1.8	13.1	13.6	−1.3	11.3	11.6	−0.3	9.8	9.7	−0.7	7.1	7.6	−1.0	5.5	6.0	−0.1
9 a. m.	17.5	17.6	−0.9	14.4	13.6	−1.3	13.0	11.7	−0.2	11.0	10.0	−0.4	9.1	8.1	−0.5	7.4	6.7	+0.6
10 a. m.	18.7	18.7	+0.2	13.3	13.3	−1.6	10.7	10.9	−1.0	9.2	9.5	−0.9	8.2	8.0	−0.6	7.1	6.8	+0.7
11 a. m.	20.0	19.7	+1.2	12.1	13.3	−1.6	9.1	10.3	−1.6	8.2	9.0	−1.4	6.6	7.6	−1.0	5.9	6.2	+0.1
12 noon	20.4	20.6	+2.1	14.4	14.3	−0.6	11.1	10.9	−1.0	9.6	9.2	−1.2	8.1	7.9	−0.7	5.6	5.8	−0.3
1 p. m.	21.4	21.4	+2.9	16.4	15.5	+0.6	12.4	11.9	0.0	9.7	9.5	−0.9	9.0	8.8	+0.2	6.0	6.1	0.0
2 p. m.	22.5	22.2	+3.7	15.6	15.6	+0.7	12.1	11.9	0.0	9.3	9.8	−0.6	9.4	9.5	+0.9	6.8	6.7	+0.6
3 p. m.	22.7	22.6	+4.1	14.7	16.4	+1.5	11.3	12.1	+0.2	10.4	10.3	−0.1	10.1	10.0	+1.4	7.2	7.2	+1.1
4 p. m.	22.6	22.5	+4.0	18.8	17.1	+2.2	12.8	12.5	+0.6	11.3	11.1	+0.7	10.6	10.2	+1.6	7.7	7.6	+1.5
5 p. m.	22.2	21.9	+3.4	17.7	17.5	+2.6	13.3	12.7	+0.8	11.5	10.6	+0.2	9.9	9.4	+0.8	7.8	7.0	+0.9
6 p. m.	21.0	21.0	+2.5	16.1	16.3	+1.4	11.9	11.9	0.0	9.1	9.6	−0.8	7.6	8.3	−0.3	5.6	6.2	+0.1
7 p. m.	19.8	20.0	+1.5	15.2	16.0	+1.1	10.5	11.5	−0.4	8.1	9.6	−0.8	7.3	8.4	−0.2	5.2	6.1	0.0
8 p. m.	19.3	19.2	+0.7	16.6	16.1	+1.2	12.2	12.4	+0.5	11.5	11.0	+0.6	10.3	9.5	+0.9	7.4	6.9	+0.8
9 p. m.	18.6	18.6	+0.1	16.6	16.1	+1.2	14.5	13.0	+1.1	13.5	11.9	+1.5	10.9	10.0	+1.4	8.1	7.4	+1.3
10 p. m.	17.9	17.7	−0.8	15.0	15.1	+0.2	12.3	12.2	+0.3	10.7	10.8	+0.4	8.8	8.9	+0.3	6.7	6.6	+0.5
11 p. m.	16.6	17.2	−1.3	13.7	14.6	−0.3	9.7	11.4	−0.5	8.3	10.0	−0.4	7.1	8.3	−0.3	5.1	5.7	−0.4
12 midnight	17.0	16.6	−1.9	15.0	14.5	−0.4	12.1	11.2	−0.7	10.9	9.9	−0.5	8.8	7.7	−0.9	5.4	5.2	−0.9
Means	18.5	....	.....	14.9	....	.....	11.9	....	.....	10.4	....	.....	8.6	....	.....	6.1	....	.....

TABLE IV.—*Absolute humidities at Mount Weather, July 27, 1912.*

Hour.	526 m. (surface).			1,000 m.			1,500 m.		
	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.
	g/cu. m.	g/cu. m.	g/cu. m.	g/cu. m.	g/cu. m.	g/cu. m.	g/cu. m.	g/cu. m.	g/cu. m.
1 a. m.	10.8	10.8	+0.9	8.6	9.1	+1.2	5.8	6.4	+1.0
2 a. m.	10.8	10.8	+0.9	9.1	9.0	+1.1	5.7	5.6	+0.2
3 a. m.	10.8	10.8	+0.9	9.2	8.9	+1.0	5.3	5.4	0.0
4 a. m.	10.8	10.7	+0.8	8.5	8.6	+0.7	5.1	5.2	−0.2
5 a. m.	10.4	10.6	+0.7	8.2	8.3	+0.4	5.2	5.2	−0.2
6 a. m.	10.5	10.5	+0.6	8.2	8.3	+0.4	5.4	5.4	0.0
7 a. m.	10.6	10.6	+0.7	8.4	8.4	+0.5	5.5	5.5	+0.1
8 a. m.	10.7	10.8	+0.9	8.7	8.4	+0.5	5.6	5.5	+0.1
9 a. m.	11.2	10.7	+0.8	8.2	7.9	0.0	5.3	5.0	−0.4
10 a. m.	10.1	10.2	+0.3	6.9	6.9	−1.0	4.2	4.2	−1.2
11 a. m.	9.4	9.6	−0.3	5.5	6.3	−1.6	3.1	3.7	−1.7
12 noon	9.4	9.3	−0.6	6.6	6.5	−1.4	4.0	4.0	−1.4
1 p. m.	9.1	9.0	−0.9	7.5	6.9	−1.0	4.9	4.3	−1.1
2 p. m.	8.6	8.7	−1.2	6.6	6.7	−1.2	4.0	4.1	−1.3
3 p. m.	8.5	8.4	−1.5	6.0	6.6	−1.3	3.3	4.5	−0.9
4 p. m.	8.1	8.4	−1.5	7.3	7.0	−0.9	6.2	5.2	−0.2
5 p. m.	8.7	8.8	−1.1	7.6	7.5	−0.4	6.2	5.9	+0.5
6 p. m.	9.6	9.3	−0.6	7.7	7.7	−0.2	5.2	5.7	+0.3
7 p. m.	9.7	9.6	−0.3	7.9	8.1	+0.2	5.6	6.2	+0.8
8 p. m.	9.4	9.5	−0.4	8.7	8.5	+0.6	7.9	6.9	+1.5
9 p. m.	9.5	9.5	−0.4	8.8	8.6	+0.7	7.1	6.8	+1.4
10 p. m.	9.7	9.9	0.0	8.3	8.3	+0.4	5.5	6.0	+0.6
11 p. m.	10.6	10.3	+0.4	7.9	8.6	+0.7	5.4	6.2	+0.8
12 midnight	10.7	10.7	+0.8	9.6	8.7	+0.8	7.8	6.2	+0.8
Means	9.9	....	....	7.9	....	....	5.4	....	....

TABLE IV.—*Absolute humidities at Mount Weather, July 27, 1912*—Continued.

Hour.	2,000 m.			2,500 m.			3,000 m.		
	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.
	g/cu. m.	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*
1 a. m.	3.6	3.6	+0.7	2.1	2.1	+0.2	2.4	2.2	+0.6
2 a. m.	3.7	3.2	+0.3	2.2	2.0	+0.1	2.1	2.1	+0.5
3 a. m.	2.4	2.9	0.0	1.6	1.9	0.0	1.7	2.0	+0.4
4 a. m.	2.5	2.7	−0.2	1.8	1.8	−0.1	2.2	2.3	+0.7
5 a. m.	3.1	2.8	−0.1	2.0	1.8	−0.1	2.9	2.5	+0.9
6 a. m.	2.8	2.9	0.0	1.7	1.8	−0.1	2.3	2.2	+0.6
7 a. m.	2.8	3.2	+0.3	1.6	2.0	+0.1	1.5	1.7	+0.1
8 a. m.	4.1	3.7	+0.8	2.6	2.4	+0.5	1.4	1.4	−0.2
9 a. m.	4.3	3.7	+0.8	3.0	2.5	+0.6	1.4	1.3	−0.3
10 a. m.	2.6	2.7	−0.2	1.8	1.9	0.0	1.2	1.1	−0.5
11 a. m.	1.1	2.1	−0.8	0.9	1.2	−0.7	0.8	0.9	−0.7
12 noon	2.6	2.5	−0.4	0.8	0.9	−1.0	0.7	0.7	−0.9
1 p. m.	3.7	2.8	−0.1	1.1	1.1	−0.8	0.7	0.7	−0.9
2 p. m.	2.1	2.3	−0.6	1.3	1.1	−0.8	0.7	0.8	−0.8
3 p. m.	1.0	2.4	−0.5	0.9	1.2	−0.7	0.9	0.9	−0.7
4 p. m.	4.0	3.1	+0.2	1.3	1.5	−0.4	1.1	1.1	−0.5
5 p. m.	4.3	3.4	+0.5	2.3	1.9	0.0	1.4	1.4	−0.2
6 p. m.	2.0	2.7	−0.2	2.0	2.0	+0.1	1.6	1.6	0.0
7 p. m.	1.7	2.4	−0.5	1.8	2.0	+0.1	1.7	1.6	0.0
8 p. m.	3.6	3.0	+0.1	2.2	2.2	+0.3	1.4	1.5	−0.1
9 p. m.	3.7	3.4	+0.5	2.5	2.4	+0.5	1.4	1.8	+0.2
10 p. m.	2.8	3.0	+0.1	2.4	2.4	+0.5	2.5	2.2	+0.6
11 p. m.	2.6	3.0	+0.1	2.2	2.2	+0.3	2.6	2.4	+0.8
12 midnight	3.5	3.2	+0.3	2.0	2.1	+0.2	2.2	2.4	+0.8
Means	2.9	....	....	1.9	....	....	1.6	....	....

TABLE V.—*Free air temperatures at Mount Weather, July 29–30, 1912.*

Hour.	526 m. (surface).			1,000 m.			1,500 m.			2,000 m.			2,500 m.			3,000 m.		
	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.
	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*
1 a. m.	17.3	17.2	−2.2	13.0	13.2	−2.4	11.4	11.3	−1.1	10.0	9.8	−0.1	6.4	6.8	0.0	3.1	3.9	0.0
2 a. m.	16.4	16.5	−2.9	11.2	12.8	−2.8	8.5	10.6	−1.8	7.3	9.3	−0.6	5.1	6.1	−0.7	2.2	2.7	−1.2
3 a. m.	15.9	15.8	−3.6	14.1	13.2	−2.4	11.8	10.9	−1.5	10.7	10.1	+0.2	6.8	6.6	−0.2	2.9	2.9	−1.0
4 a. m.	15.2	15.2	−4.2	14.2	13.7	−1.9	12.3	12.0	−0.4	12.3	11.3	+1.4	7.9	7.6	+0.8	3.6	3.6	−0.3
5 a. m.	14.5	14.8	−4.6	12.8	13.1	−2.5	11.8	11.8	−0.6	11.0	11.1	+1.2	8.2	8.1	+1.3	4.2	4.1	+0.2
6 a. m.	14.6	14.8	−4.6	12.3	12.8	−2.8	11.3	11.4	−1.0	10.1	10.3	+0.4	8.1	8.0	+1.2	4.5	4.4	+0.5
7 a. m.	15.2	15.4	−4.0	13.3	13.2	−2.4	11.2	11.2	−1.2	9.7	9.6	−0.3	7.7	7.5	+0.7	4.5	4.4	+0.5
8 a. m.	16.4	16.6	−2.8	13.9	14.0	−1.6	11.2	11.2	−1.2	9.0	9.0	−0.9	6.8	6.8	0.0	4.3	3.9	0.0
9 a. m.	18.2	18.1	−1.3	14.7	14.6	−1.0	11.2	11.4	−1.0	8.2	8.7	−1.2	5.8	6.2	−0.6	3.0	3.3	−0.6
10 a. m.	19.6	19.5	+0.1	15.3	15.1	−0.5	11.8	11.7	−0.7	8.9	8.7	−1.2	5.9	5.9	−0.9	2.7	3.0	−0.9
11 a. m.	20.8	20.7	+1.3	15.4	15.4	−0.2	12.0	11.7	−0.7	8.9	8.6	−1.3	5.9	5.5	−1.3	3.4	2.9	−1.0
12 noon	21.6	21.8	+2.4	15.5	16.4	+0.8	11.2	13.0	+0.6	7.9	9.6	−0.3	4.7	6.2	−0.6	2.6	3.6	−0.3
1 p. m.	22.9	22.8	+3.4	18.2	17.0	+1.4	15.7	13.0	+0.6	12.0	9.8	−0.1	8.1	6.2	−0.6	4.7	3.3	−0.6
2 p. m.	24.0	23.6	+4.2	17.3	18.0	+2.4	12.2	13.9	+1.5	9.6	10.5	+0.6	5.8	6.8	0.0	2.6	3.4	−0.5
3 p. m.	24.0	24.0	+4.6	18.6	18.4	+2.8	13.7	13.7	+1.3	9.9	10.1	+0.2	6.4	6.6	−0.2	3.0	3.3	−0.6
4 p. m.	24.1	24.2	+4.8	19.3	19.0	+3.4	15.1	14.4	+2.0	10.7	9.9	0.0	7.5	6.6	−0.2	4.3	3.7	−0.2
5 p. m.	24.5	24.1	+4.7	19.1	18.8	+3.2	14.3	13.9	+1.5	9.2	9.2	−0.7	6.0	6.1	−0.7	3.9	3.7	−0.2
6 p. m.	23.6	23.5	+4.1	18.1	18.3	+2.7	12.4	13.4	+1.0	7.7	8.8	−1.1	4.7	5.5	−1.3	2.9	3.6	−0.3
7 p. m.	22.4	22.1	+2.7	17.8	17.9	+2.3	13.5	13.5	+1.1	9.6	9.6	−0.3	5.8	6.1	−0.7	3.9	4.0	+0.1
8 p. m.	20.3	20.8	+1.4	17.9	17.3	+1.7	14.7	13.7	+1.3	11.6	10.6	+0.7	7.7	7.0	+0.2	5.3	4.8	+0.9
9 p. m.	19.7	19.7	+0.3	16.3	16.3	+0.7	12.9	13.0	+0.6	10.5	10.6	+0.7	7.4	7.4	+0.6	5.1	5.1	+1.2
10 p. m.	19.2	19.1	−0.3	14.7	15.5	−0.1	11.4	12.5	+0.1	9.6	10.2	+0.3	7.0	7.6	+0.8	4.9	5.3	+1.4
11 p. m.	18.5	18.5	−0.9	15.4	15.1	−0.5	13.1	12.8	+0.4	10.6	10.8	+0.9	8.4	8.1	+1.3	5.8	5.7	+1.8
12 midnight	17.8	17.9	−1.5	15.3	14.6	−1.0	13.9	12.8	+0.4	12.2	10.9	+1.0	8.8	7.9	+1.1	6.3	5.1	+1.2
Means	19.4	....	.....	15.6	....	.....	12.4	....	.....	9.9	....	.....	6.8	....	.....	3.9	....	.....

TABLE VI.—*Absolute humidities at Mount Weather, July 29–30, 1912.*

Hour.	526 m. (surface).			1,000 m.			1,500 m.		
	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.
	g/cu. m.	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*
1 a. m.	11.7	11.8	−0.3	9.4	9.6	−0.4	7.7	7.9	0.0
2 a. m.	11.5	11.4	−0.7	9.1	9.5	−0.5	7.4	7.6	−0.3
3 a. m.	10.9	11.0	−1.1	10.0	9.7	−0.3	7.8	7.4	−0.5
4 a. m.	10.5	10.8	−1.3	9.9	9.7	−0.3	7.1	6.3	−1.6
5 a. m.	11.1	11.0	−1.1	9.2	9.5	−0.5	4.0	5.3	−2.6
6 a. m.	11.4	11.3	−0.8	9.3	9.4	−0.6	4.9	5.5	−2.4
7 a. m.	11.5	11.6	−0.5	9.6	9.2	−0.8	7.6	6.5	−1.4
8 a. m.	11.9	11.9	−0.2	8.7	9.0	−1.0	7.0	6.9	−1.0
9 a. m.	12.2	12.1	0.0	8.6	9.1	−0.9	6.1	7.2	−0.7
10 a. m.	12.1	12.2	+0.1	10.1	9.8	−0.2	8.4	7.8	−0.1
11 a. m.	12.4	12.5	+0.4	10.6	10.5	+0.5	9.0	8.7	+0.8
12 noon	13.0	13.0	+0.9	10.7	10.7	+0.7	8.6	8.7	+0.8
1 p. m.	13.6	13.0	+0.9	10.9	10.8	+0.8	8.6	8.8	+0.9
2 p. m.	12.5	13.2	+1.1	10.9	11.0	+1.0	9.1	9.2	+1.3
3 p. m.	13.4	13.0	+0.9	11.3	11.2	+1.2	9.9	9.7	+1.8
4 p. m.	13.0	13.2	+1.1	11.5	11.1	+1.1	10.0	9.6	+1.7
5 p. m.	13.1	12.9	+0.8	10.6	10.5	+0.5	8.9	9.0	+1.1
6 p. m.	12.7	12.3	+0.2	9.5	10.2	+0.2	8.2	8.7	+0.8
7 p. m.	11.2	11.8	−0.3	10.4	10.6	+0.6	9.0	8.9	+1.0
8 p. m.	11.4	11.6	−0.5	11.8	10.7	+0.7	9.6	8.7	+0.8
9 p. m.	12.1	12.0	−0.1	9.9	10.3	+0.3	7.4	7.9	0.0
10 p. m.	12.5	12.4	+0.3	9.3	9.7	−0.3	6.7	7.6	−0.3
11 p. m.	12.5	12.4	+0.3	10.0	9.9	−0.1	8.6	8.0	+0.1
12 midnight	12.2	12.1	0.0	10.4	9.9	−0.1	8.7	8.3	+0.4
Means	12.1	....	....	10.0	....	....	7.9	....	....

Hour.	2,000 m.			2,500 m.			3,000 m.		
	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.
	g/cu. m.	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*
1 a. m.	4.3	4.7	−1.0	2.6	2.9	−1.2	1.2	1.4	−1.1
2 a. m.	4.3	4.5	−1.2	2.0	2.3	−1.8	0.8	1.0	−1.5
3 a. m.	5.0	4.7	−1.0	2.2	2.3	−1.8	1.1	1.2	−1.3
4 a. m.	4.7	4.4	−1.3	2.7	2.6	−1.5	1.6	1.5	−1.0
5 a. m.	3.5	3.7	−2.0	3.0	2.8	−1.3	1.9	1.8	−0.7
6 a. m.	2.9	3.1	−2.6	2.6	2.5	−1.6	1.9	1.9	−0.6
7 a. m.	2.9	3.4	−2.3	2.2	2.7	−1.4	1.8	2.0	−0.5
8 a. m.	4.5	4.4	−1.3	3.4	3.4	−0.7	2.4	2.6	+0.1
9 a. m.	5.9	5.8	+0.1	4.5	4.4	+0.3	3.5	3.3	+0.8
10 a. m.	6.9	6.7	+1.0	5.2	5.1	+1.0	4.0	3.8	+1.3
11 a. m.	7.3	7.1	+1.4	5.5	5.2	+1.1	3.9	3.7	+1.2
12 noon	7.1	6.8	+1.1	5.0	4.9	+0.8	3.1	3.4	+0.9
1 p. m.	6.1	6.4	+0.7	4.3	4.4	+0.3	3.1	2.7	+0.2
2 p. m.	6.1	6.6	+0.9	3.9	4.4	+0.3	2.0	2.4	−0.1
3 p. m.	7.5	7.2	+1.5	4.9	4.8	+0.7	2.2	2.3	−0.2
4 p. m.	8.0	7.7	+2.0	5.5	5.1	+1.0	2.7	2.5	0.0
5 p. m.	7.5	7.6	+1.9	4.9	5.0	+0.9	2.7	2.6	+0.1
6 p. m.	7.2	7.3	+1.6	4.5	5.0	+0.9	2.5	2.9	+0.4
7 p. m.	7.3	7.2	+1.5	5.6	5.4	+1.3	3.4	3.2	+0.7
8 p. m.	7.2	6.5	+0.8	6.0	5.4	+1.3	3.8	3.4	+0.9
9 p. m.	5.1	5.5	−0.2	4.7	5.0	+0.9	3.1	3.0	+0.5
10 p. m.	4.3	4.9	−0.8	4.2	4.5	+0.4	2.2	2.6	+0.1
11 p. m.	5.4	5.1	−0.6	4.6	4.3	+0.2	2.5	2.3	−0.2
12 midnight	5.6	5.1	−0.6	4.2	3.8	−0.3	2.3	2.0	−0.5
Means	5.7	....	....	4.1	....	....	2.5	....	....

TABLE VII.—*Free air temperatures at Mount Weather, Aug. 19–20, 1912.*

Hour.	526 m. (surface).			1,000 m.			1,500 m.			2,000 m.			2,500 m.			3,000 m.		
	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.
	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.
1 a. m.	21.7	21.6	−1.4	18.9	19.3	−0.7	17.3	17.3	+0.2	15.1	14.9	+0.4	11.7	11.5	−0.1	7.3	7.1	−0.9
2 a. m.	21.5	21.5	−1.5	20.1	19.5	−0.5	18.5	17.7	+0.6	16.1	15.2	+0.7	12.8	11.6	0.0	7.7	7.2	−0.8
3 a. m.	21.2	21.2	−1.8	19.4	19.2	−0.8	17.3	17.5	+0.4	14.3	14.2	−0.3	10.3	10.6	−1.0	6.7	6.7	−1.3
4 a. m.	20.9	21.0	−2.0	18.0	19.0	−1.0	16.6	16.9	−0.2	12.2	13.5	−1.0	8.8	9.9	−1.7	5.8	6.7	−1.3
5 a. m.	21.0	21.1	−1.9	19.6	18.9	−1.1	16.7	16.7	−0.4	14.1	13.7	−0.8	10.5	10.3	−1.3	7.5	7.4	−0.6
6 a. m.	21.3	21.3	−1.7	19.0	19.0	−1.0	16.7	16.6	−0.5	14.7	14.4	−0.1	11.7	11.3	−0.3	8.8	8.3	+0.3
7 a. m.	21.5	21.3	−1.7	18.4	18.7	−1.3	16.3	16.4	−0.7	14.5	14.7	+0.2	11.8	12.0	+0.4	8.7	9.0	+1.0
8 a. m.	21.1	22.1	−0.9	18.6	19.0	−1.0	16.3	16.8	−0.3	14.8	15.2	+0.7	12.5	12.6	+1.0	9.5	9.5	+1.5
9 a. m.	23.6	23.0	0.0	20.1	19.7	−0.3	17.8	17.4	+0.3	16.3	15.9	+1.4	13.5	13.3	+1.7	10.4	10.1	+2.1
10 a. m.	24.2	24.2	+1.2	20.4	20.1	+0.1	18.0	17.4	+0.3	16.5	16.0	+1.5	13.8	13.5	+1.9	10.5	9.7	+1.7
11 a. m.	24.7	24.9	+1.9	19.9	20.7	+0.7	16.3	17.3	+0.2	15.1	15.6	+1.1	13.1	13.0	+1.4	8.2	9.2	+1.2
12 noon	25.7	26.0	+3.0	21.7	20.3	+0.3	17.7	17.5	+0.4	15.2	15.3	+0.8	12.2	12.5	+0.9	8.8	8.6	+0.6
1 p. m.	27.5	26.2	+3.2	22.3	22.0	+2.0	18.4	18.0	+0.9	15.5	15.2	+0.7	12.3	12.2	+0.6	8.9	8.8	+0.8
2 p. m.	25.4	25.9	+2.9	22.1	22.0	+2.0	17.9	17.7	+0.6	15.0	14.8	+0.3	12.0	11.7	+0.1	8.7	8.3	+0.3
3 p. m.	24.7	25.2	+2.2	21.5	21.4	+1.4	16.9	17.1	0.0	13.8	14.1	−0.4	10.9	11.3	−0.3	7.2	7.7	−0.3
4 p. m.	25.4	25.2	+2.2	20.7	21.5	+1.5	16.6	17.1	0.0	13.6	13.9	−0.6	10.9	11.1	−0.5	7.3	7.5	−0.5
5 p. m.	25.6	24.8	+1.8	22.2	20.9	+0.9	17.7	17.0	−0.1	14.2	13.7	−0.8	11.6	11.1	−0.5	7.9	7.8	−0.2
6 p. m.	23.5	23.4	+0.4	19.9	19.9	−0.1	16.6	16.5	−0.6	13.4	13.4	−1.1	10.8	10.9	−0.7	8.1	7.8	−0.2
7 p. m.	21.2	22.1	−0.9	17.5	18.9	−1.1	15.1	15.8	−1.3	12.5	12.7	−1.8	10.4	10.0	−1.6	7.5	7.0	−1.0
8 p. m.	21.5	21.8	−1.2	19.3	19.2	−0.8	15.8	16.1	−1.0	12.3	13.1	−1.4	8.9	10.4	−1.2	5.5	7.1	−0.9
9 p. m.	22.8	22.5	−0.5	20.8	20.4	+0.4	17.4	17.3	+0.2	14.5	14.5	0.0	11.8	11.3	−0.3	8.2	7.7	−0.3
10 p. m.	23.2	22.5	−0.5	21.1	20.8	+0.8	18.8	17.9	+0.8	16.7	15.2	+0.7	13.3	12.2	+0.6	9.5	8.6	+0.6
11 p. m.	21.5	22.1	−0.9	20.4	20.5	+0.5	17.5	17.4	+0.3	14.5	14.9	+0.4	11.4	11.6	0.0	8.0	8.0	0.0
12 midnight	21.6	21.6	−1.4	18.9	19.5	−0.5	16.0	16.9	−0.2	13.4	14.3	−0.2	10.1	11.1	−0.5	6.4	7.2	−0.8
Means	23.0	....	....	20.0	....	....	17.1	....	....	14.5	....	....	11.6	....	....	8.0	....	....

TABLE VIII.—*Absolute humidities at Mount Weather, Aug. 19–20, 1912.*

Hour.	526 m. (surface).			1,000 m.			1,500 m.		
	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.
	g/cu. m.	g/cu. m.	g/cu. m.	g/cu. m.	g/cu. m.	g/cu. m.	g/cu. m.	g/cu. m.	g/cu. m.
1 a. m.	**14.3**	**14.3**	**−1.2**	**14.0**	**13.3**	**+0.1**	**12.2**	**10.9**	**−0.4**
2 a. m.	**14.3**	**14.5**	**−1.0**	**14.2**	**13.6**	**+0.4**	**12.8**	**12.1**	**+0.8**
3 a. m.	**14.9**	**14.8**	**−0.7**	**12.7**	**13.1**	**−0.1**	**11.3**	**11.6**	**+0.3**
4 a. m.	**15.3**	**15.2**	**−0.3**	**12.4**	**13.2**	**0.0**	**10.6**	**11.5**	**+0.2**
5 a. m.	**15.3**	**15.3**	**−0.2**	**14.6**	**14.0**	**+0.8**	**12.5**	**12.0**	**+0.7**
6 a. m.	**15.4**	**15.5**	**0.0**	**14.9**	**14.5**	**+1.3**	**12.8**	**12.2**	**+0.9**
7 a. m.	**15.7**	**15.7**	**+0.2**	**14.1**	**14.4**	**+1.2**	**11.3**	**11.8**	**+0.5**
8 a. m.	**16.0**	**16.1**	**+0.6**	**14.2**	**14.6**	**+1.4**	**11.2**	**11.8**	**+0.5**
9 a. m.	**16.5**	**16.1**	**+0.6**	**15.4**	**14.5**	**+1.3**	**12.9**	**11.9**	**+0.6**
10 a. m.	**15.8**	**16.0**	**+0.5**	**13.8**	**13.0**	**−0.2**	**11.7**	**10.8**	**−0.5**
11 a. m.	**15.8**	**16.1**	**+0.6**	**9.8**	**12.6**	**−0.6**	**7.8**	**10.7**	**−0.6**
12 noon	**16.6**	**16.4**	**+0.9**	**14.2**	**12.7**	**−0.5**	**12.5**	**11.0**	**−0.3**
1 p. m.	**16.8**	**16.1**	**+0.6**	**14.1**	**13.8**	**+0.6**	**12.8**	**12.3**	**+1.0**
2 p. m.	**14.9**	**15.7**	**+0.2**	**13.0**	**12.9**	**−0.3**	**11.6**	**11.1**	**−0.2**
3 p. m.	**15.4**	**15.8**	**+0.3**	**11.7**	**12.1**	**−1.1**	**8.9**	**9.7**	**−1.6**
4 p. m.	**17.2**	**16.1**	**+0.6**	**11.5**	**12.5**	**−0.7**	**8.6**	**9.8**	**−1.5**
5 p. m.	**15.6**	**16.1**	**+0.6**	**14.2**	**13.4**	**+0.2**	**12.0**	**11.2**	**−0.1**
6 p. m.	**15.4**	**15.7**	**+0.2**	**14.5**	**14.0**	**+0.8**	**13.1**	**12.2**	**+0.9**
7 p. m.	**16.0**	**15.7**	**+0.2**	**13.4**	**13.5**	**+0.3**	**11.6**	**11.7**	**+0.4**
8 p. m.	**15.7**	**15.6**	**+0.1**	**12.7**	**13.0**	**−0.2**	**10.3**	**11.0**	**−0.3**
9 p. m.	**15.2**	**15.2**	**−0.3**	**12.8**	**12.9**	**−0.3**	**11.0**	**10.9**	**−0.4**
10 p. m.	**14.6**	**14.6**	**−0.9**	**13.2**	**12.7**	**−0.5**	**11.4**	**10.9**	**−0.4**
11 p. m.	**14.1**	**14.3**	**−1.2**	**12.2**	**12.4**	**−0.8**	**10.4**	**10.5**	**−0.8**
12 midnight	**14.3**	**14.2**	**−1.3**	**11.7**	**12.6**	**−0.6**	**9.8**	**10.8**	**−0.5**
Means	**15.5**	....	....	**13.2**	....	....	**11.3**	....	....

TABLE VIII.—*Absolute humidities at Mount Weather, Aug. 19–20, 1912*—Continued.

Hour.	2,000 m.			2,500 m.			3,000 m.		
	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.
	g/cu. m.	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*	*g/cu. m.*
1 a. m.	10.1	9.6	+0.6	9.0	8.4	+1.0	7.4	7.2	+1.4
2 a. m.	10.6	10.0	+1.0	9.2	8.6	+1.2	7.9	7.4	+1.6
3 a. m.	9.3	9.4	+0.4	7.7	8.2	+0.8	6.8	6.9	+1.1
4 a. m.	8.4	9.3	+0.3	7.6	8.0	+0.6	6.1	6.5	+0.7
5 a. m.	10.2	9.8	+0.8	8.8	8.6	+1.2	6.5	6.5	+0.7
6 a. m.	10.9	10.0	+1.0	9.3	8.4	+1.0	6.9	6.4	+0.6
7 a. m.	8.8	9.5	+0.5	7.1	7.8	+0.4	5.7	5.9	+0.1
8 a. m.	8.9	9.0	0.0	7.0	7.1	−0.3	5.0	5.3	−0.5
9 a. m.	9.4	8.8	−0.2	7.3	6.9	−0.5	5.1	5.1	−0.7
10 a. m.	8.1	7.9	−1.1	6.4	6.2	−1.2	5.1	4.9	−0.9
11 a. m.	6.1	8.0	−1.0	5.0	6.3	−1.1	4.4	5.2	−0.6
12 noon	9.9	8.9	−0.1	7.5	6.9	−0.5	6.1	5.7	−0.1
1 p. m.	10.6	10.2	+1.2	8.1	7.9	+0.5	6.6	6.3	+0.5
2 p. m.	10.0	9.3	+0.3	8.0	7.1	−0.3	6.3	5.9	+0.1
3 p. m.	7.2	8.1	−0.9	5.3	6.3	−1.1	4.7	5.2	−0.6
4 p. m.	7.1	8.1	−0.9	5.7	6.3	−1.1	4.6	4.8	−1.0
5 p.fm.	9.9	8.9	−0.1	7.9	7.3	−0.1	5.2	5.3	−0.5
6 p. m.	9.8	9.8	+0.8	8.3	7.9	+0.5	6.1	5.9	+0.1
7 p. m.	9.6	9.1	+0.1	7.5	7.3	−0.1	6.4	5.8	0.0
8 p. m.	8.0	8.6	−0.4	6.0	6.7	−0.7	5.0	5.4	−0.4
9 p. m.	8.3	8.4	−0.6	6.6	6.6	−0.8	4.9	5.1	−0.7
10 p. m.	8.9	8.3	−0.7	7.3	6.9	−0.5	5.5	5.4	−0.4
11 p. m.	7.9	8.3	−0.7	6.7	7.0	−0.4	5.8	5.8	0.0
12 midnight	8.0	8.7	−0.3	7.0	7.6	+0.2	6.2	6.5	+0.7
Means	9.0	....	....	7.4	....	....	5.8	....	....

TABLE IX.—*Free air temperatures at Mount Weather, Aug. 23–24, 1912.*

Hour.	526 m. (surface).			1,000 m.			1,500 m.			2.000 m.		
	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.
	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.
1 a. m.	18.1	17.6	−1.7	15.1	14.8	−0.9	11.5	10.8	−0.7	7.9	7.7	−0.6
2 a. m.	16.8	16.7	−2.6	14.5	14.6	−1.1	10.6	10.8	−0.7	8.8	8.7	+0.4
3 a. m.	15.3	15.8	−3.5	14.1	14.4	−1.3	10.4	10.7	−0.8	9.5	9.5	+1.2
4 a. m.	15.2	15.5	−3.8	14.5	14.2	−1.5	11.2	10.9	−0.6	10.2	10.2	+1.9
5 a. m.	16.0	15.7	−3.6	14.1	13.8	−1.9	11.1	10.3	−1.2	11.0	10.1	+1.8
6 a. m.	15.9	16.3	−3.0	12.7	13.2	−2.5	8.6	9.7	−1.8	9.2	9.0	+0.7
7 a. m.	17.1	17.4	−1.9	12.9	13.2	−2.5	9.4	9.7	−1.8	6.7	8.1	−0.2
8 a. m.	19.3	18.9	−0.4	14.1	14.1	−1.6	11.0	10.7	−0.8	8.3	8.1	−0.2
9 a. m.	20.4	20.4	+1.1	15.3	15.3	−0.4	11.7	11.5	0.0	9.4	9.0	+0.7
10 a. m.	21.4	21.1	+1.8	16.4	16.2	+0.5	11.9	11.7	+0.2	9.4	9.2	+0.9
11 a. m.	21.6	21.6	+2.3	16.9	16.8	+1.1	11.6	12.1	+0.6	8.8	9.4	+1.1
12 noon	21.9	22.0	+2.7	17.2	16.8	+1.1	12.8	11.7	+0.2	10.1	9.0	+0.7
1 p. m.	22.6	22.1	+2.8	16.3	17.3	+1.6	10.8	12.4	+0.9	8.1	8.9	+0.6
2 p. m.	21.8	22.4	+3.1	18.3	17.7	+2.0	13.7	12.9	+1.4	8.6	8.5	+0.2
3 p. m.	22.8	22.4	+3.1	18.6	18.1	+2.4	14.3	13.1	+1.6	8.8	7.9	−0.4
4 p. m.	22.7	22.3	+3.0	17.3	17.9	+2.2	11.3	12.9	+1.4	6.3	7.7	−0.6
5 p. m.	21.3	21.3	+2.0	17.7	17.7	+2.0	13.0	12.8	+1.3	7.9	7.7	−0.6
6 p. m.	19.9	20.5	+1.2	18.0	17.4	+1.7	14.2	13.1	+1.6	9.0	8.1	−0.2
7 p. m.	20.3	19.6	+0.3	16.5	16.6	+0.9	12.0	12.2	+0.7	7.5	7.7	−0.6
8 p. m.	18.5	19.2	−0.1	15.3	16.1	+0.4	10.3	11.5	0.0	6.6	7.3	−1.0
9 p. m.	18.8	18.6	−0.7	16.4	15.8	+0.1	12.2	11.3	−0.2	7.8	7.3	−1.0
10 p. m.	18.5	18.5	−0.8	15.6	15.4	−0.3	11.4	10.9	−0.6	7.5	6.9	−1.4
11 p. m.	18.2	18.2	−1.1	14.2	14.9	−0.8	9.1	10.3	−1.2	5.5	6.5	−1.8
12 midnight	18.0	18.1	−1.2	14.8	14.7	−1.0	10.4	10.3	−1.2	6.4	6.5	−1.8
Means	19.3	......	......	15.7	......	......	11.5	......	......	8.3	......	......

TABLE X.—*Soil temperatures at 2 and at 20 centimeters below surface.*

Hour.	July means.		July 26.		July 27.		July 29.		July 30.		August means.		Aug. 19.		Aug. 20.		Aug. 23.		Aug. 24.	
	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.
1 a. m.	23.1	24.9	21.6	23.4	20.0	23.2	22.3	24.2	19.9	23.6	20.8	23.4	23.5	24.4	23.0	24.7	22.9	24.7	20.2	23.6
2 a. m.	22.7	24.7	21.4	23.3	19.7	23.0	21.9	24.0	19.6	23.4	20.6	23.3	23.2	24.4	22.8	24.6	22.5	24.7	19.9	23.4
3 a. m.	22.5	24.7	21.3	23.3	19.4	22.9	21.8	23.9	19.1	23.3	20.3	23.1	22.9	24.4	22.7	24.5	22.2	25.6	15.6	23.3
4 a. m.	22.3	24.6	21.1	23.2	19.2	22.8	21.5	23.8	18.6	23.2	20.1	23.1	22.8	24.3	22.5	24.4	21.8	24.4	19.3	23.3
5 a. m.	22.1	24.4	21.0	23.2	18.9	22.7	21.3	23.9	18.3	23.1	19.9	22.9	22.7	24.1	22.4	24.3	21.5	24.3	19.0	23.1
6 a. m.	21.9	24.3	20.8	23.2	18.8	22.7	21.2	23.8	18.2	22.9	19.8	22.8	22.7	24.1	22.5	24.2	21.2	24.1	18.9	22.9
7 a. m.	22.3	24.2	20.8	23.1	18.9	22.5	21.4	23.7	18.3	22.8	19.9	22.8	22.8	24.0	22.8	24.1	21.5	24.1	19.0	22.8
8 a. m.	22.9	24.1	21.1	22.9	19.6	22.4	21.6	23.5	19.0	22.7	20.7	22.7	23.9	23.9	23.6	24.1	21.8	24.1	19.9	22.7
9 a. m.	24.2	24.1	22.2	23.1	21.1	22.6	22.2	23.4	21.1	22.7	21.8	22.7	24.3	23.8	25.0	24.0	22.3	24.0	21.9	22.7
10 a. m.	26.2	24.1	22.9	23.2	22.8	22.7	22.4	23.2	22.8	22.7	23.4	22.7	26.7	23.8	26.1	24.1	23.1	23.9	24.4	22.7
11 a. m.	27.8	24.2	23.6	23.3	25.1	22.8	22.2	23.2	24.2	22.7	25.0	22.8	28.3	24.0	26.2	24.1	24.1	23.9	27.2	22.9
12 noon	29.1	24.3	24.6	23.3	26.6	23.0	22.8	23.2	24.6	22.8	26.2	22.9	29.2	24.2	27.7	23.9	26.4	24.0	28.7	23.1
1 p. m.	30.3	24.4	25.7	23.4	28.0	23.2	25.8	23.1	25.6	22.8	27.1	23.0	30.8	24.2	26.7	24.3	27.5	24.1	30.5	23.3
2 p. m.	30.4	24.6	26.6	23.3	28.7	23.8	26.8	23.1	26.1	22.9	27.3	23.2	28.6	24.6	28.4	24.2	27.1	24.1	30.7	23.4
3 p. m.	29.6	24.8	25.6	23.6	28.3	23.4	25.9	23.2	25.3	23.1	27.3	23.3	28.4	24.7	26.7	24.4	26.3	24.1	30.4	23.7
4 p. m.	28.9	24.9	24.4	23.7	26.4	23.6	25.5	23.3	24.9	23.1	26.5	23.4	28.3	24.6	26.0	24.5	26.2	24.2	28.9	23.8
5 p. m.	28.1	24.9	24.1	23.7	25.7	23.6	25.3	23.4	23.9	23.3	25.7	23.5	27.5	24.9	25.9	24.6	25.4	24.3	27.5	23.9
6 p. m.	27.1	25.1	23.7	23.8	24.4	23.8	24.2	23.6	23.3	23.3	24.7	23.7	26.4	25.3	25.3	24.7	24.3	24.3	26.1	24.1
7 p. m.	26.1	25.2	22.9	23.8	23.1	23.9	22.8	23.8	22.2	23.4	23.7	23.8	25.1	25.6	24.7	24.7	23.3	24.4	24.7	24.2
8 p. m.	25.1	25.2	22.2	23.8	22.1	23.9	22.2	23.9	21.4	23.4	22.9	23.8	24.8	25.4	24.3	24.7	22.2	24.3	23.9	24.3
9 p. m.	24.4	25.2	21.5	23.7	21.4	23.8	21.7	23.9	20.8	23.3	22.3	23.7	24.4	25.2	23.9	24.6	21.7	24.1	23.2	24.2
10 p. m.	24.1	25.1	21.2	23.6	20.9	23.7	21.2	23.8	20.2	23.2	21.9	23.7	24.1	25.0	23.4	24.5	21.1	24.0	22.7	24.1
11 p. m.	24.1	25.0	20.7	23.3	20.4	23.6	20.8	23.7	19.9	23.2	21.5	23.6	23.6	24.9	23.2	24.4	20.7	23.9	22.4	23.9
12 midnight	23.3	24.9	20.4	23.3	20.1	23.4	20.4	23.6	19.5	23.0	21.2	23.5	23.2	24.8	23.1	24.4	20.4	23.8	22.1	23.9

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Alt.	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
July 1, 1912:	*mm.*	*C.*	*%*		*m. p. s.*	*m.*	*mm.*	*C.*	*%*	*g/cu.m.*		*m. p. s.*	*Volts.*
7.52 a. m.	722.1	15.0	82	sse.	5.8	526	722.1	15.0	82	10.4	sse.	5.8	......
7.57 a. m.	722.1	15.1	82	sse.	4.5	737	704.4	12.9	78	8.7	se.	10.0	0
7.58 a. m.	722.1	15.1	82	sse.	4.5	850	695.0	13.8	60	7.1	se.	13.5	0
8.37 a. m.	722.5	15.4	87	se.	5.8	1,369	653.8	11.9	59	6.2	s.	7.1	0
10.08 a. m.	723.2	15.8	86	se.	4.5	1,712	627.8	8.4	72	6.1	s.	6.8	0
10.28 a. m.	723.3	16.0	86	se.	4.5	1,390	652.6	9.7	61	5.6	s.	5.6	0
10.53 a. m.	723.4	16.6	76	se.	4.5	914	691.0	11.7	76	7.9	sse.	11.0	0
11.02 a. m.	723.4	16.9	68	se.	4.5	526	723.4	16.9	68	9.7	se.	4.5	......
July 2, 1912:													
6.24 a. m.	724.5	15.8	69	s.	6.3	526	724.5	15.8	69	9.2	s.	6.3	......
6.26 a. m.	724.5	15.8	69	s.	6.3	656	713.5	16.8	44	6.2	s.	16.4	0
6.34 a. m.	724.6	15.9	70	s.	7.2	934	690.7	15.7	39	5.2	s.	12.2	0
6.41 a. m.	724.6	15.9	69	s.	7.2	951	689.4	16.9	39	5.6	s.	9.6	0
6.50 a. m.	724.6	16.0	70	s.	6.7	1,272	663.9	13.6	72	8.4	ssw.	8.8	0
7.01 a. m.	724.7	16.2	64	s.	6.3	1,462	648.9	11.8	83	8.7	ssw.	9.7	0
9.32 a. m.	724.9	19.4	61	s.	7.6	1,245	666.3	14.8	76	9.5	ssw.	5.4	0
9.40 a. m.	724.9	19.4	63	s.	6.7	1,117	676.3	15.5	72	9.4	s.	7.0	0
9.47 a. m.	724.9	19.4	60	s.	8.0	1,004	685.5	15.9	45	6.0	s.	9.3	0
9.52 a. m.	724.9	19.4	60	sse.	8.0	807	701.5	15.4	48	6.3	sse.	11.9	0
9.58 a. m.	724.9	19.4	60	sse.	6.3	526	724.9	19.4	60	9.9	sse.	6.3	......

July 1, 1912.—Seven kites were used; lifting surface, 44.6 sq. m. Wire out, 6,200 m.; at maximum altitude, 5,400 m.

St.-Cu. from the northwest and very low ones from the southeast covered the sky to 9.35 a. m.; thereafter, St. from the southeast covered the sky.

High pressure (770 mm.) was central over Ontario. Low pressure (754 mm.) was central over Saskatchewan.

July 2, 1912.—Five kites were used; lifting surface, 32.0 sq. m. Wire out, 4,300 m.; at maximum altitude, 2,000 m.

A.-Cu., from the southwest, decreased from 7/10 to a few.

High pressure (773 mm.) central over Delaware Bay covered the United States east of the Mississippi River.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Alt.	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
July 3, 1912:	*mm.*	*C.*	*%*		*m. p. s.*	*m.*	*mm.*	*C.*	*%*	*g/cu.m.*		*m. p. s.*	*Volts.*
6.57 p. m.	720.8	23.8	73	s.	4.5	526	720.8	23.8	73	15.6	s.	4.5	......
7.08 p. m.	720.8	23.8	73	s.	4.5	860	693.8	21.8	76	14.4	s.	9.7	0
7.21 p. m.	720.8	23.6	72	s.	4.0	1,165	669.9	20.0	68	11.6	sw.	8.2	0
7.37 p. m.	720.8	23.2	74	sse.	4.5	1,408	651.0	17.0	69	9.9	sw.	7.1	0
8.12 p. m.	720.8	23.0	75	s.	4.9	1,828	619.5	12.3	86	9.3	sw.	8.0	......
8.21 p. m.	720.9	22.9	76	s.	4.5	1,358	654.6	15.9	82	11.0	sw.	7.9	......
8.29 p. m.	720.9	22.8	76	s.	4.5	908	689.8	18.8	78	12.4	s.	11.6	0
8.40 p. m.	720.9	22.8	76	s.	4.5	526	720.9	22.8	76	15.3	s.	4.5	......
July 4, 1912:													
1.07 p. m.	719.4	26.4	67	s.	5.8	526	719.4	26.4	67	16.5	s.	5.8	......
1.15 p. m.	719.2	26.8	63	s.	6.7	748	701.4	23.4	68	14.2	sse.	8.0	0
1.50 p. m.	718.9	27.6	62	s.	5.4	1,179	667.3	19.7	79	13.3	sse.	10.3	0
3.02 p. m.	718.6	26.8	63	sse.	5.8	1,621	633.3	16.5	64	8.9	sse.	4.9	0
3.18 p. m.	718.5	26.7	65	sse.	5.4	1,156	668.5	18.6	82	12.9	sse.	12.0	0
3.28 p. m.	718.5	26.5	64	sse.	4.9	772	698.7	22.2	76	14.8	sse.	13.0	0
3.36 p. m.	718.4	25.9	65	sse.	5.8	526	718.4	25.9	65	15.7	sse.	5.8	......
July 5, 1912:													
1.33 p. m.	720.5	26.6	54	sse.	6.7	526	720.5	26.6	54	13.5	sse.	6.7	......
1.39 p. m.	720.4	26.9	55	s.	6.7	795	698.7	23.6	57	12.0	sse.	10.2	0
1.59 p. m.	720.4	27.0	56	sse.	6.7	1,133	672.1	20.2	67	11.6	sse.	9.2	0
2.36 p. m.	720.4	26.1	60	sse.	6.3	1,424	649.7	16.4	85	11.8	sse.	10.0	0
2.50 p. m.	720.4	26.4	57	sse.	6.3	914	689.2	20.8	72	12.9	sse.	9.2	0
2.57 p. m.	720.4	25.6	60	sse.	6.3	526	720.4	25.6	60	14.1	sse.	6.3	......
July 6, 1912:													
6.41 p. m.	721.6	24.2	69	se.	5.8	526	721.6	24.2	69	15.0	se.	5.8	......
7.08 p. m.	721.6	23.2	71	se.	5.8	894	691.8	21.4	73	13.6	se.	8.7	0
7.54 p. m.	721.6	22.6	73	se.	5.4	1,013	682.4	20.0	73	12.5	sse.	8.2	0
8.03 p. m.	721.6	22.4	73	se.	4.9	1,279	660.0	17.6	69	10.3	sse.	6.7	0
8.08 p. m.	721.6	22.3	74	se.	4.9	911	690.4	19.9	76	12.9	sse.	8.7	0
8.18 p. m.	721.7	22.0	74	se.	4.9	526	721.7	22.0	74	14.2	se.	4.9	......

July 3, 1912.—Four kites were used; lifting surface, 31.6 sq. m. Wire out, 2,900 m.; at maximum altitude, 2,000 m.

There were 2/10 A.-St. and 1/10 Cu., from the west.

At 8 a. m. high pressure (771 mm.) central over Virginia covered the eastern half of the United States.

July 4, 1912.—Five kites were used; lifting surface, 38.4 sq. m. Wire out, 3,400 m.; at maximum altitude, 2,800 m.

1/10 Ci.-St. from the northwest and 3/10 Cu. from the south-southeast at the beginning of the flight changed to 2/10 Ci.-St. from the northwest. 7/10 Cu. from the south-southeast and 1/10 St. from the northwest at the close of the flight. A thunderstorm was noted brewing in the west at 2.57 p. m.

High pressure (768 mm.) was central just off the Virginia coast and (766 mm.) off the north California coast. Low pressure (754 mm.) was central over southeastern Colorado.

July 5, 1912.—Three kites were used; lifting surface, 24.8 sq. m. Wire out, 1,700 m.; at maximum altitude 1,100 m.

Cu. from the south, increased from 4/10 to 8/10.

Pressure was high (767 mm.) east of the Middle Atlantic coast. Low pressure (755 mm.) was central over the Dakotas.

July 6, 1912.—Two kites were used; lifting surface, 18 sq. m. Wire out, 1,600 m.; at maximum altitude 1,200 m.

The sky was cloudless before 8 p. m.; thereafter there were a few A.-St. of no apparent direction on the western horizon.

At 8 a. m. high pressure (770 mm.) was central over New Jersey and covered the eastern half of the United States.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m. Pressure.	Temperature.	Rel. hum.	Wind. Dir.	Wind. Vel.	At different heights above sea. Alt.	Pressure.	Temperature.	Humidity. Rel.	Humidity. Abs.	Wind. Dir.	Wind. Vel.	P. D. kite and earth.
July 10, 1912:	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%	*g/cu.m.*		*m. p. s.*	*Volts.*
8.48 a. m.	718.8	23.0	82	wnw.	8.0	526	718.8	23.0	82	16.7	wnw.	8.0	......
9.02 a. m.	718.8	23.0	82	nw.	8.0	940	685.4	19.9	84	14.3	nw.	15.1	0
9.16 a. m.	718.8	23.4	81	nw.	7.6	1,127	670.7	19.9	75	12.8	nw.	9.7	0
11.08 a. m.	718.4	25.3	72	wnw.	7.2	526	718.4	25.3	72	16.7	wnw.	7.2	......
July 19, 1912:													
First flight—													
6.22 a. m.	718.4	17.8	88	nw.	10.7	526	718.4	17.8	88	13.2	nw.	10.7	......
6.32 a. m.	718.5	17.7	89	nw.	12.1	942	684.3	13.2	99	11.3	nw.	18.4	0
6.40 a. m.	718.5	17.2	87	nw.	12.5	1,434	645.2	10.5	88	8.5	nw.	20.4	0
6.47 a. m.	718.6	16.8	86	nw.	12.1	1,570	634.9	13.3	72	8.2	nw.	22.4	0
7.02 a. m.	718.7	16.8	84	nw.	12.5	2,105	595.9	11.3	65	6.6	wnw.	20.4	426
7.19 a. m.	718.8	16.6	84	nw.	13.4	3,123	527.0	6.1	52	3.8	w.	22.4	835
7.35 a. m.	718.8	16.4	83	nw.	15.6	3,717	490.0	1.5	35	1.9	w.	22.7	......
7.58 a. m.	718.9	16.6	84	nw.	13.0	3,311	515.3	4.9	36	2.4	wnw.	23.5	755
8.14 a. m.	719.1	16.1	78	nw.	16.1	2,768	550.6	8.3	25	2.1	wnw.	20.7	550
8.30 a. m.	719.3	15.8	72	nw.	20.1	2,270	584.7	11.1	37	3.7	wnw.	22.4	330
8.42 a. m.	719.5	15.9	72	nw.	17.0	2,060	599.6	11.7	44	4.6	nw.	19.5	230
8.45 a. m.	719.5	15.9	72	nw.	16.5	1,957	607.1	11.5	50	5.1	nw.	19.5	180
8.54 a. m.	719.6	15.9	71	nw.	11.2	1,580	634.9	14.7	66	8.2	nw.	23.5	0
9.05 a. m.	719.7	16.0	70	nw.	9.8	1,412	647.8	12.0	59	6.2	nnw.	17.7	0
9.08 a. m.	719.8	15.8	73	nw.	9.4	1,313	655.5	12.2	57	6.1	nnw.	18.0	0
9.12 a. m.	719.8	15.5	76	nw.	8.9	1,114	671.2	10.7	68	6.6	nnw.	18.0	0
9.21 a. m.	719.8	16.4	72	nw.	9.4	921	687.0	11.5	86	8.8	nnw.	13.3	0
9.30 a. m.	719.9	16.8	71	nw.	13.4	526	719.9	16.8	71	10.1	nw.	13.4	......
Second flight—													
10.00 a. m.	720.1	16.8	64	nw.	12.5	526	720.1	16.8	64	9.1	nw.	12.5	......
10.15 a. m.	720.1	16.4	69	nw.	13.4	1,016	679.7	12.4	58	6.3	nw.	18.0	0
10.21 a. m.	720.1	16.8	65	nw.	11.2	1,277	658.9	14.3	44	5.4	nw.	17.0	0
10.34 a. m.	720.2	17.5	64	nw.	12.1	1,699	626.9	13.1	46	5.2	nw.	15.1	0
10.37 a. m.	720.2	17.7	64	nw.	11.6	1,889	613.1	13.3	31	3.6	nw.	15.1	0
10.45 a. m.	720.2	17.6	59	nw.	11.2	2,269	585.9	11.3	21	2.1	nw.	16.8	170
10.59 a. m.	720.2	17.8	63	nw.	10.7	3,054	533.1	7.2	14	1.1	nw.	20.4	260
11.21 a. m.	720.2	17.8	63	nw.	11.6	3,745	489.3	3.0	10	0.6	wnw.	24.5	515
11.45 a. m.	720.3	18.5	64	nw.	8.5	3,178	523.8	5.9	8	0.6	wnw.	20.4	380
12.04 p. m.	720.3	18.6	63	nw.	8.9	2,674	556.9	8.2	8	0.7	nw.	19.9	260
12.06 p. m.	720.3	18.6	63	nw.	8.9	2,604	561.6	9.1	8	0.7	nw.	18.3	250
12.10 p. m.	720.3	18.7	60	nw.	9.4	2,289	583.4	7.8	7	0.6	nw.	17.3	230
12.19 p. m.	720.3	18.8	59	nw.	9.8	1,641	630.7	10.6	7	0.7	nw.	15.3	0
12.21 p. m.	720.3	18.7	60	nw.	9.8	1,623	632.0	7.4	12	1.0	nw.	15.3	0
12.29 p. m.	720.3	18.7	61	nw.	10.3	1,575	635.8	9.8	16	1.5	nw.	14.9	0
12.30 p. m.	720.3	18.7	61	nw.	10.3	1,343	653.7	8.1	24	2.0	nw.	13.4	0
12.35 p. m.	720.4	18.8	61	nw.	9.4	987	682.3	11.2	62	6.2	nw.	13.3	0
12.49 p. m.	720.4	18.9	59	nw.	8.0	526	720.4	18.9	59	9.5	nw.	8.0	......

July 10, 1912.—Four kites were used; lifting surface, 25.7 sq. m. Wire out, 2,400 m.; at maximum altitude 1,400 m.

St.-Cu. from the northwest and A.-Cu. from the west decreased from 10/10 to 4/10 before 11 a. m. Thereafter there were 4/10 A.-Cu. and Cu. from the west. Rain fell from 9.02 to 9.15 a. m.

Pressure was low (757 mm.) over the Gulf of St. Lawrence; and high (767 mm.) over the South Atlantic States.

July 19, 1912.—*First flight:* Four kites were used; lifting surface, 25.2 sq. m. Wire out, 5,000 m.; at maximum altitude, 4,900 m.

There were 9/10 to 3/10 St.-Cu. from the northwest. After 9 a. m. there were a few Ci. from the west-northwest. The head kite was in St.-Cu. from 6.27 to 6.46 a. m.; altitude, 1,000 m.

At 8 a. m. low pressure (754 mm.) was central over the lower St. Lawrence Valley and high pressure (771 mm.) was central over Lake Michigan.

Second flight: Four kites were used; lifting surface, 25.2 sq. m. Wire out, 5,500 m., at maximum altitude.

There were few to 4/10 Ci. and few to 1/10 Cu. from the west-northwest. The head kite was in passing Cu. at intervals from 11.21 to 11.50 a. m.; altitude, 3,200 m.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Alt.	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
July 19, 1912:													
Third flight—	*mm.*	*C.*	*%*		*m. p. s.*	*m.*	*mm.*	*C.*	*%*	*g/cu. m.*		*m. p. s.*	*Volts.*
1.17 p. m..	720.4	19.2	55	nw.	7.6	526	720.4	19.2	55	9.0	nw.	7.6	......
1.22 p. m..	720.4	19.6	59	nw.	8.9	750	701.8	16.3	58	8.0	nw.	11.2	0
1.43 p. m..	720.4	19.4	57	nw.	9.8	1,208	664.8	11.6	75	7.7	nw.	11.7	0
1.58 p. m..	720.4	19.8	56	nw.	10.7	1,540	639.0	9.6	71	6.5	nw.	15.3	0
1.59 p. m..	720.4	19.8	57	nw.	10.7	1,707	626.3	11.4	56	5.7	nw.	15.3	0
2.22 p. m..	720.5	20.2	55	nw.	7.2	1,949	608.6	10.6	14	1.4	nw.	12.2	0
2.29 p. m..	720.5	20.2	56	nw.	7.2	2,684	557.0	7.9	12	1.0	nw.	19.9	0
2.30 p. m..	720.5	20.1	57	nw.	7.2	2,903	542.6	8.5	12	1.0	nw.	19.9	0
2.34 p. m..	720.5	19.9	62	nw.	8.0	3,048	533.2	7.8	11	0.9	wnw.	19.4	0
2.55 p. m..	720.6	21.0	54	nw.	10.3	3,489	505.2	4.6	7	0.5	wnw.	23.5	980
3.05 p. m..	720.6	20.3	52	nw.	10.7	4,121	466.8	−0.2	6	0.3	wnw.	27.5	1,105
3.21 p. m..	720.7	20.4	54	nw.	7.2	3,663	493.8	2.6	6	0.4	wnw.	23.4	860
3.35 p. m..	720.7	20.4	56	nw.	8.5	3,001	535.6	5.6	6	0.4	wnw.	20.4	515
3.56 p. m..	720.8	20.8	53	nw.	8.5	2,052	601.1	8.3	5	0.4	wnw.	13.8	0
4.05 p. m..	720.8	20.6	52	nw.	6.7	1,899	612.3	9.6	4	0.4	wnw.	14.4	0
4.06 p. m..	720.8	20.5	53	nw.	6.7	1,710	626.3	7.5	6	0.5	wnw.	7.3	0
4.13 p. m..	720.8	20.8	53	nw.	6.7	1,250	662.2	10.6	48	4.6	wnw.	11.2	0
4.25 p. m..	720.8	20.6	52	nw.	7.2	888	691.1	15.4	54	7.0	wnw.	12.8	0
4.30 p. m..	720.8	20.4	53	nw.	7.6	526	720.8	20.4	53	9.3	nw.	7.6	......
Fourth flight—													
5.06 p. m..	720.9	20.0	55	nw.	8.0	526	720.9	20.0	55	9.4	nw.	8.0	......
5.21 p. m..	720.9	20.2	51	nw.	5.8	953	686.0	16.2	56	7.6	nw.	10.2	0
6.10 p. m..	720.9	18.6	58	nnw.	4.9	1,180	667.7	13.9	62	7.4	nnw.	8.7	0
6.16 p. m..	721.0	18.7	59	nnw.	4.5	1,800	620.4	12.1	37	3.9	nnw.	10.2	0
6.24 p. m..	721.0	18.8	59	nnw.	4.9	1,646	631.8	9.9	46	4.3	nnw.	10.2	0
6.32 p. m..	721.0	18.9	60	nnw.	5.4	1,427	648.4	11.3	65	6.6	nnw.	10.2	0
6.40 p. m..	721.0	18.7	59	nnw.	5.4	1,478	644.5	11.4	40	4.1	nnw.	11.4	0
6.45 p. m..	721.0	18.6	58	nnw.	6.3	1,512	641.9	12.8	30	3.3	nnw.	11.4	0
7.02 p. m..	721.1	18.2	57	nnw.	6.3	1,987	606.6	10.9	18	1.8	nnw.	8.2	0
7.54 p. m..	721.4	17.2	58	nnw.	4.0	2,196	591.7	8.1	14	1.2	nnw.	8.7	0
8.08 p. m..	721.5	17.4	58	nnw.	4.5	2,369	579.5	8.1	14	1.2	nnw.	11.4	0
8.15 p. m..	721.6	17.4	58	nnw.	4.5	1,918	611.6	9.9	14	1.3	nnw.	7.3	0
8.16 p. m..	721.6	17.4	58	nnw.	4.5	1,782	621.6	9.3	14	1.2	nnw.	8.7	0
8.21 p. m..	721.6	17.1	57	nnw.	4.5	1,448	647.1	10.8	26	2.6	nnw.	10.2	0
8.30 p. m..	721.7	17.0	57	n.	5.4	989	683.4	13.2	40	4.6	n.	9.2	0
8.39 p. m..	721.8	17.0	57	n.	6.7	526	721.8	17.0	57	8.2	n.	6.7	......
July 26, 1912:													
First flight—													
8.30 a. m...	709.2	19.5	74	wnw.	16.1	526	709.2	19.5	74	12.3	wnw.	16.1	......
9.10 a. m...	709.4	18.8	71	nw.	12.5	1,116	661.9	14.1	82	9.9	nw.	22.4	0
9.22 a. m...	709.5	18.9	70	nw.	13.4	1,625	623.1	8.6	99	8.4	nnw.	20.4	0
9.29 a. m...	709.6	18.6	72	nw.	13.4	1,883	604.1	8.0	96	7.9	nnw.	20.9	0
9.30 a. m...	709.6	18.6	72	nw.	9.8	1,953	599.1	8.5	76	6.4	nnw.	20.9	0
9.41 a. m...	709.7	18.9	72	nw.	9.8	2,617	552.5	3.2	88	5.3	nnw.	21.4	260
9.47 a. m...	709.8	19.0	71	nw.	13.4	2,709	546.4	2.7	87	5.0	nnw.	22.2	300
9.51 a. m...	709.8	19.0	70	wnw.	15.6	2,871	535.6	5.0	68	4.6	nnw.	25.3	360
10.14 a. m..	710.0	19.2	69	wnw.	15.2	3,665	485.6	1.0	50	3.0	nnw.	25.7	......

July 19, 1912.—Third flight: Five kites were used; lifting surface, 31.5 sq. m. Wire out, 5,500 m., at maximum altitude.

There was 1/10 Cu. from the north-northwest before 2 p. m.; then there were 2/10 to few Cu. from the northwest. At 2.34 p. m. the head kite entered Cu., the altitude of whose base was 2,500 m.

Fourth flight: Five kites were used; lifting surface, 34.5 sq. m. Wire out, 4,000 m.; at maximum altitude, 3,000 m.

There were 7/10 to 8/10 Ci. and a few Ci.-St. from the northwest. A solo halo was observed from 5.50 to 6. 10 p. m.

July 26, 1912.—First flight: Four kites were used; lifting surface, 25.2 sq. m. Wire out, 5,000 m.; at maximum altitude, 4,800 m.

St.-Cu. from the north-northwest varied from 7/10 to 9/10. At 10 a. m. there were a few A.-Cu. from the north-northwest. The head kite was in St.-Cu., altitude of base 1,300 m., at 9.22, 11.21, and 11.31 a. m.

At 8 a. m. high pressure (766 mm.) was central over Minnesota and low pressure (749 mm.) over Nova Scotia.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind. Dir.	Wind. Vel.	Alt.	Pressure.	Temperature.	Humidity. Rel.	Humidity. Abs.	Wind. Dir.	Wind. Vel.	P. D. kite and earth.
July 26, 1912:													
First flight—	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%	*g/cu.m.*		*m. p. s.*	*Volts.*
10.34 a. m.	710.1	18.8	71	wnw.	12.1	3,249	510.9	3.2	54	3.2	nnw.	23.7	490
10.58 a. m.	710.3	19.0	71	wnw.	11.6	2,505	559.7	6.3	66	4.9	nnw.	20.4	330
11.03 a. m.	710.3	19.2	71	wnw.	10.3	2,330	571.9	4.4	78	5.1	nnw.	18.7	130
11.10 a. m.	710.3	19.3	72	nnw.	13.4	1,980	596.7	6.8	78	5.9	nnw.	19.2	0
11.15 a. m.	710.3	19.5	72	nnw.	10.7	1,761	613.0	6.1	94	6.8	nnw.	18.7	0
11.35 a. m.	710.4	19.4	72	nw.	12.5	944	676.3	12.6	87	9.6	nw.	17.3	0
11.49 a. m.	710.4	19.4	71	wnw.	13.0	526	710.4	19.4	71	11.7	wnw.	13.0	......
Second flight—													
12.25 p. m.	710.4	19.6	71	nw.	11.6	526	710.4	19.6	71	11.9	nw.	11.6	......
12.34 p. m.	710.5	19.8	68	wnw.	12.1	960	675.4	15.6	82	10.8	nw.	16.8	0
12.56 p. m.	710.5	19.8	70	nw.	13.0	1,717	617.2	9.0	95	8.3	nnw.	18.6	0
12.57 p. m.	710.5	19.8	69	nw.	13.0	1,787	612.1	9.8	78	7.2	nnw.	18.6	0
1.09 p. m.	710.5	20.2	71	nw.	12.1	2,206	582.1	9.3	66	5.9	nnw.	16.9	330
1.38 p. m.	710.6	20.8	70	nw.	9.8	3,032	526.5	3.3	69	4.2	nnw.	14.8	615
1.45 p. m.	710.6	21.0	69	nw.	8.9	3,219	514.6	5.1	46	3.1	nnw.	23.5	615
2.22 p. m.	710.7	20.3	68	nw.	9.8	3,695	484.7	0.9	48	2.5	nnw.	25.2	......
2.54 p. m.	710.9	20.7	68	nw.	10.3	3,092	521.7	5.1	42	2.9	nnw.	18.8	614
2.57 p. m.	710.9	20.6	69	nw.	8.9	2,983	528.7	4.1	45	2.9	nnw.	18.8	610
3.08 p. m.	710.9	20.1	70	nw.	11.6	2,796	540.8	5.1	54	3.7	nnw.	20.8	500
3.15 p. m.	711.0	19.8	71	nw.	10.7	2,513	560.0	3.4	83	5.0	nnw.	21.4	330
3.33 p. m.	711.0	19.8	71	nw.	8.0	1,975	598.2	6.6	96	7.2	nnw.	19.6	260
3.35 p. m.	711.0	19.8	71	nw.	8.0	1,838	608.2	6.1	100	7.3	nnw.	19.6	0
3.42 p. m.	711.0	19.8	71	nw.	9.8	1,617	624.8	7.5	94	7.5	nnw.	19.9	0
4.14 p. m.	711.1	20.2	71	nw.	8.9	950	676.7	14.4	84	10.3	nnw.	15.3	0
4.19 p. m.	711.2	20.1	74	nw.	8.0	526	711.2	20.1	74	12.7	nw.	8.0	......
Third flight—													
5.02 p. m.	711.3	20.6	67	nw.	9.8	526	711.3	20.6	67	11.9	nw.	9.8	......
5.12 p. m.	711.3	20.5	68	nw.	9.8	1,016	671.8	15.8	83	11.1	nnw.	14.8	0
5.26 p. m.	711.4	20.1	70	nw.	8.0	1,609	626.5	11.8	83	8.7	nnw.	17.3	0
5.40 p. m.	711.5	19.8	71	nw.	10.7	2,392	570.3	6.5	83	6.2	nnw.	22.4	390
5.41 p. m.	711.5	19.9	70	nw.	10.7	2,586	557.0	8.4	58	5.0	nnw.	22.4	565
5.50 p. m.	711.5	20.0	71	nw.	10.3	2,951	532.9	7.0	47	3.6	nnw.	12.8	560
6.25 p. m.	711.8	19.2	78	wnw.	7.2	3,934	471.8	0.6	30	1.5	nnw.	25.3	......
6.56 p. m.	712.0	18.8	78	wnw.	7.2	2,878	536.5	5.8	43	3.1	nnw.	21.2	260
7.05 p. m.	712.0	18.7	80	wnw.	7.6	2,627	553.3	6.1	51	3.7	nnw.	19.2	230
7.07 p. m.	712.0	18.7	80	wnw.	7.6	2,413	567.9	3.8	72	4.5	nnw.	19.2	190
7.20 p. m.	712.1	18.6	81	wnw.	6.3	2,100	590.1	5.9	91	6.5	nnw.	18.4	170
7.32 p. m.	712.2	18.1	83	wnw.	7.2	1,624	625.2	8.6	83	7.1	nnw.	18.4	0
7.52 p. m.	712.4	17.6	85	wnw.	7.2	1,0(8	673.1	13.6	87	10.2	nnw.	14.8	0
8.00 p. m.	712.4	17.6	85	wnw.	6.3	526	712.4	17.6	85	12.6	wnw.	6.3	......
Fourth flight—													
8.49 p. m.	712.6	17.4	85	wnw.	6.7	526	712.6	17.4	85	12.5	wnw.	6.7	......
9.00 p. m.	712.7	17.2	84	wnw.	7.2	1,018	672.7	14.9	82	10.4	nnw.	19.4	0
9.16 p. m.	712.8	17.2	84	wnw.	6.7	1,541	632.5	10.9	88	8.7	nnw.	17.6	0
9.24 p. m.	712.8	17.2	84	wnw.	6.7	1,794	613.5	8.5	97	8.2	nnw.	15.6	0
9.34 p. m.	712.9	17.4	82	wnw.	7.6	2,174	586.1	6.1	85	6.2	nw.	18.4	0
9.48 p. m.	712.9	17.1	84	wnw.	6.7	2,500	562.9	4.2	86	5.6	nw.	13.8	170
9.58 p. m.	713.0	17.2	83	wnw.	7.2	2,751	546.1	6.8	41	3.1	nnw.	20.7	170
10.07 p. m.	713.0	17.1	83	wnw.	7.2	2,805	542.4	5.3	40	2.8	nnw.	18.6	220
10.10 p. m.	713.0	17.1	84	wnw.	7.2	2,842	540.0	6.0	34	2.5	nnw.	18.6	260
10.19 p. m.	713.1	17.0	84	wnw.	6.7	2,935	534.1	6.0	24	1.7	nnw.	18.6	425
10.40 p. m.	713.1	16.8	86	wnw.	7.2	4,056	465.2	1.7	28	1.5	nnw.	27.1	......
11.01 p. m.	713.2	16.6	87	wnw.	7.2	3,022	528.2	4.9	29	2.0	nnw.	19.4	260
11.14 p. m.	713.2	16.5	86	wnw.	8.5	2,552	559.3	7.3	34	2.7	nnw.	16.2	200
11.17 p. m.	713.2	16.4	86	wnw.	8.5	2,304	576.3	6.5	35	2.6	nnw.	15.3	170
11.25 p. m.	713.2	16.6	86	wnw.	8.5	2,112	589.9	7.6	33	2.6	nnw.	15.3	170

July 26, 1912.—Second flight: Five kites were used; lifting surface, 31.5 sq. m. Wire out, 6,000 m.; at maximum altitude, 5,650 m.

St.-Cu. from the north-northwest decreased from 8/10 to 3/10. The head kite entered St.-Cu., altitude of base 1,450 m., at 12.43 and emerged at 12.57 p. m.

Third flight: Five kites were used; lifting surface, 31.5 sq. m. Wire out, 6,000 m.; at maximum altitude, 5,700 m.

St.-Cu., altitude 1,400 m. and Cu., from the north-northwest, increased from 2/10 to 4/10 before 6.20 p. m., afterwards decreasing to 1/10.

Fourth flight: Five kites were used; lifting surface, 33.5 sq. m. Wire out, 6,000 m.; at maximum altitude, 5,300 m.

St.-Cu. from the north-northwest, decreased from 2/10 to none before 11.20 p. m.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Alt.	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
July 26, 1912:													
Fourth flight—	*mm.*	*C.*	*%*		*m. p. s.*	*m.*	*mm.*	*C.*	*%*	*g/cu. m.*		*m. p. s.*	*Volts.*
11.27 p. m..	713.2	16.6	86	wnw.	8.5	1,992	598.5	6.7	38	2.9	nnw.	15.3	0
11.39 p. m..	713.3	16.4	86	wnw.	8.9	1,471	637.7	9.2	79	7.0	nnw.	16.8	0
11.47 p. m..	713.3	16.4	86	wnw.	8.0	1,006	674.6	13.6	70	7.9	nnw.	22.4	0
July 27, 1912:													
12.00 mdt..	713.3	16.2	87	wnw.	8.9	526	713.3	16.2	87	11.9	wnw.	8.9	......
Fifth flight—													
12.41 a. m..	713.4	15.8	90	wnw.	8.0	526	713.4	15.8	90	12.0	wnw.	8.0	......
12.49 a. m..	713.5	15.8	89	wnw.	8.0	949	678.9	14.1	78	9.4	nnw.	17.3	0
1.07 a. m...	713.5	15.6	90	wnw.	7.6	1,515	634.7	10.2	66	6.2	nnw.	12.4	170
1.13 a. m...	713.5	15.6	90	wnw.	8.5	1,803	613.0	8.3	76	6.4	nnw.	13.3	260
1.30 a. m...	713.6	15.6	90	wnw.	8.5	1,804	613.0	9.7	56	5.1	nnw.	8.9	260
1.42 a. m...	713.6	15.4	92	wnw.	8.0	1,804	613.0	10.0	56	5.2	nnw.	9.4	260
2.01 a. m...	713.6	15.2	92	wnw.	8.0	2,061	594.3	8.8	38	3.3	nnw.	7.6	170
2.13 a. m...	713.6	15.2	92	wnw.	8.0	2,837	540.7	3.9	35	2.2	nnw.	11.1	170
2.16 a. m...	713.7	15.2	92	wnw.	8.0	2,911	535.9	4.4	30	2.0	nnw.	14.1	170
2.18 a. m...	713.7	15.2	92	wnw.	8.0	2,932	534.7	4.3	32	2.1	nnw.	10.0	......
2.25 a. m...	713.7	15.2	92	wnw.	8.0	2,587	557.6	6.1	34	2.5	nnw.	10.2	170
2.37 a. m...	713.7	15.2	92	wnw.	7.6	2,359	573.4	8.5	27	2.3	nnw.	9.8	0
2.39 a. m...	713.7	15.2	92	wnw.	7.6	2,218	583.2	8.2	29	2.4	nnw.	10.2	0
2.42 a. m...	713.7	15.2	92	wnw.	7.6	1,958	601.8	9.8	29	2.7	nnw.	10.2	0
2.50 a. m...	713.8	15.1	92	wnw.	7.2	1,855	609.3	8.9	29	2.5	nnw.	15.1	0
2.59 a. m...	713.8	15.0	92	wnw.	7.2	1,432	641.1	10.4	65	6.2	nnw.	12.8	0
3.12 a. m...	713.8	14.8	94	wnw.	8.0	1,000	674.9	13.0	85	9.6	nnw.	18.4	0
3.19 a. m...	713.8	14.7	94	wnw.	7.6	526	713.8	14.7	94	11.7	wnw.	7.6	......
Sixth flight—													
3.58 a. m...	713.8	14.8	92	wnw.	10.7	526	713.8	14.8	92	11.6	wnw.	10.7	......
4.06 a. m...	713.8	14.9	91	wnw.	10.7	880	684.7	15.4	71	9.2	nnw.	19.4	0
4.15 a. m...	713.8	15.0	90	wnw.	10.7	1,294	651.9	12.6	70	7.7	nnw.	16.5	0
4.19 a. m...	713.9	15.1	89	wnw.	10.7	1,345	648.1	12.6	64	7.0	nnw.	13.9	0
4.22 a. m...	713.9	15.1	89	wnw.	10.7	1,602	628.8	13.6	46	5.4	nnw.	14.8	170
4.40 a. m...	713.9	14.8	90	wnw.	10.7	2,070	594.8	11.6	26	2.7	nnw.	9.2	170
5.08 a. m...	714.1	14.8	88	wnw.	11.2	2,388	572.6	8.8	27	2.3	n.	7.1	170
5.31 a. m...	714.4	15.0	88	wnw.	12.5	2,891	538.8	3.8	46	2.8	nnw.	16.8	260
5.35 a. m...	714.5	15.0	88	wnw.	10.3	3,479	501.4	3.5	47	2.9	nnw.	25.5	......
5.41 a. m...	714.5	14.9	88	wnw.	10.7	4,132	461.9	1.0	39	2.0	nnw.	31.6	......
5.49 a. m...	714.6	14.9	88	wnw.	11.2	4,029	467.3	0.6	38	1.9	nnw.	31.6	......
6.15 a. m...	714.8	15.0	88	wnw.	9.8	3,262	514.1	3.8	29	1.8	nnw.	21.0	170
6.24 a. m...	714.9	15.1	87	wnw.	8.5	2,805	543.7	6.2	27	2.0	nnw.	18.0	0
6.27 a. m...	714.9	15.2	87	wnw.	8.9	2,450	567.7	5.9	26	1.9	nnw.	13.3	0
6.37 a. m...	714.9	15.4	85	wnw.	9.8	2,030	597.3	8.7	31	2.7	nnw.	11.1	0
6.44 a. m...	714.9	15.5	84	wnw.	9.8	1,774	616.1	7.8	34	2.8	nnw.	15.3	0
6.46 a. m...	715.0	15.5	84	wnw.	9.8	1,775	616.1	8.3	38	3.2	nnw.	15.7	0
6.48 a. m...	715.0	15.5	84	wnw.	10.3	1,757	617.4	7.6	38	3.0	nnw.	15.7	0
7.04 a. m...	715.0	15.8	83	wnw.	10.7	1,354	648.1	10.6	74	7.2	nw.	18.7	0
7.10 a. m...	715.1	15.7	84	wnw.	9.8	928	682.0	12.6	82	9.0	nnw.	17.3	0
7.20 a. m...	715.2	15.8	84	wnw.	10.3	526	715.2	15.8	84	11.2	wnw.	10.3	......
Seventh flight—													
7.53 a. m...	715.4	16.4	81	wnw.	10.7	526	715.4	16.4	81	11.2	wnw.	10.7	......
8.10 a. m...	715.6	16.7	79	wnw.	10.3	948	680.9	12.6	82	9.0	nw.	13.3	0
8.13 a. m...	715.6	16.7	79	wnw.	10.3	1,111	667.8	13.2	76	8.6	nw.	20.3	0
8.29 a. m...	715.7	17.0	79	wnw.	9.8	1,617	629.0	10.9	50	4.9	nw.	17.6	0

July 27, 1912.—Fifth flight: Six kites were used; lifting surface, 39.8 sq. m. Wire out, 6,000 m.; at maximum altitude, 4,200 m.

There were a few St.-Cu. from the north-northwest about 2 a. m.

Sixth flight: Seven kites were used; lifting surface, 46.1 sq. m. Wire out, 6,200 m.; at maximum altitude, 5,650 m.

There were a few Cu. on the southeastern horizon about 6.10 a. m.; also light haze after 5.10 a. m.

Seventh flight: Six kites were used; lifting surface, 38.3 sq. m. Wire out, 6,200 m.; at maximum altitude, 5,750 m.

There were a few Cu. from the northwest about 8.20 a. m. The head kite was in Cu., altitude 1,500 m., at 8.19 a. m.

High pressure (769 mm.), central over the upper St. Lawrence, covered the eastern United States.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind. Dir.	Wind. Vel.	Alt.	Pressure.	Temperature.	Humidity. Rel.	Humidity. Abs.	Wind. Dir.	Wind. Vel.	P. D. kite and earth.
July 27, 1912:													
Seventh flight—	*mm.*	*C.*	*%*		*m. p. s.*	*m.*	*mm.*	*C.*	*%*	*g/cu.m.*		*m. p. s.*	*Volts.*
8.33 a. m...	715.7	16.8	80	wnw.	9.8	1,718	621.4	12.3	38	4.1	nnw.	16.6	0
8.43 a. m...	715.8	17.0	82	wnw.	7.6	2,082	595.1	9.6	50	4.5	nnw.	12.2	0
8.58 a. m...	715.9	17.3	79	wnw.	8.0	2,416	571.7	8.0	49	4.0	nnw.	13.3	0
9.06 a. m...	715.9	17.6	76	wnw.	8.0	2,594	559.6	9.6	27	2.5	nnw.	17.7	0
9.16 a. m...	715.9	17.8	75	wnw.	8.0	2,648	555.9	8.7	20	1.7	nnw.	17.7	170
9.44 a. m...	715.9	18.4	66	wnw.	8.9	3,068	528.5	7.2	16	1.2	nnw.	19.0	615
9.54 a. m...	715.9	18.5	68	wnw.	8.9	3,777	484.6	1.8	14	0.8	nnw.	24.5	640
10.03 a. m..	715.9	18.7	65	wnw.	11.2	4,417	446.8	−2.0	15	0.6	nnw.	29.6	......
10.24 a. m..	715.9	19.0	61	wnw.	9.8	3,788	482.3	1.4	17	0.9	nnw.	26.5	515
10.42 a. m..	715.9	19.6	59	wnw.	8.9	2,870	540.3	4.0	14	0.9	nnw.	17.8	170
11.12 a. m..	715.9	19.8	56	wnw.	6.7	2,058	596.3	9.2	14	1.2	nw.	14.8	0
11.13 a. m..	715.9	19.8	55	wnw.	6.7	1,955	603.8	8.0	14	1.2	nw.	14.8	0
11.14 a. m..	715.9	19.9	55	wnw.	6.7	1,871	610.0	8.2	15	1.2	nw.	14.8	0
11.15 a. m..	715.9	19.9	55	wnw.	6.7	1,820	613.8	8.1	17	1.4	nw.	14.8	0
11.23 a. m..	715.9	20.2	52	wnw.	7.2	1,516	636.7	10.0	33	3.1	nw.	19.9	0
11.27 a. m..	715.9	20.1	50	wnw.	9.8	1,234	658.6	9.2	34	3.0	nw.	18.2	0
11.36 a. m..	715.8	20.2	53	wnw.	9.8	839	690.2	15.0	57	7.2	nw.	11.7	0
11.44 a. m..	715.8	20.8	54	wnw.	7.2	526	715.8	20.8	54	9.7	wnw.	7.2	......
Eighth flight—													
12.20 p. m..	715.8	20.5	54	nw.	8.9	526	715.8	20.5	54	9.5	nw.	8.9	......
12.25 p. m..	715.8	20.9	54	nw.	8.0	856	689.0	17.4	53	7.8	nw.	11.7	0
12.39 p. m..	715.8	21.2	51	nw.	8.0	1,272	656.2	13.2	61	7 0	nw.	12.8	0
12.43 p. m..	715.8	21.2	50	nw.	7.2	1,488	639.5	11.8	51	5.0	nw.	15.8	0
12.45 p. m..	715.8	21.2	50	nw.	7.2	1,505	638.2	12.4	44	4.8	nw.	15.3	0
1.11 p. m...	715.8	21.6	48	nw.	8.9	1,981	602.8	9.8	42	3.9	nw.	10.9	0
2.16 p. m...	715.7	22.7	43	nw.	8.9	2,299	580.4	10.7	15	1.5	nw.	10.2	0
2.33 p. m...	715.6	22.8	42	nw.	9.4	2,762	548.9	8.6	11	0.9	nw.	14.3	......
2.40 p. m...	715.6	22.8	41	nw.	9.4	2,101	594.1	11.9	10	1.0	nw.	15.3	0
2.46 p. m...	715.6	22.5	41	nw.	7.6	2,135	591.6	9.3	10	0.9	nw.	15.3	0
2.48 p. m...	715.6	22.5	41	nw.	7.6	1,757	619.1	10.7	11	1.0	nw.	15.3	0
2.49 p. m...	715.6	22.4	41	nw.	7.6	1,686	624.2	10.3	13	1.2	nw.	15.3	0
2.53 p. m...	715.6	22.4	41	nw.	7.6	1,604	630.5	10.9	27	2.7	nw.	13.9	0
3.08 p. m...	715.6	22.6	43	nw.	7.6	805	693.0	16.2	51	7.0	nw.	12.4	0
3.13 p. m...	715.6	22.8	42	nw.	8.5	526	715.6	22.8	42	8.4	nw.	8.5	......
Ninth flight—													
3.42 p. m...	715.7	22.8	41	nnw.	8.5	526	715.7	22.8	41	8.2	nnw.	8.5	
3.53 p. m...	715.7	22.6	42	nnw.	8.9	882	687.1	20.4	43	7.5	nnw.	12.8	0
4.09 p. m...	715.7	22.9	39	nnw.	8.9	1,302	654.3	15.6	50	6.6	nw.	14.3	0
4.23 p. m...	715.7	22.6	42	nnw.	8.0	1,675	626.1	11.8	57	6.0	nw.	13.8	0
4.38 p. m...	715.8	22.7	44	nnw.	8.5	2,255	584.7	12.6	30	3.3	nw.	15.3	0
4.56 p. m...	715.8	22.4	42	nnw.	7.6	2,574	562.7	10.2	19	1.8	nnw.	12.8	0
5.04 p. m...	715.8	22.4	42	nnw.	8.9	3,102	528.0	7.7	16	1.3	nnw.	17.6	0
5.22 p. m...	715.8	22.0	46	nnw.	8.9	3,381	510.4	6.0	13	0.9	nnw.	18.9	755
5.35 p. m...	715.9	21.8	46	nnw.	6.7	3,858	480.6	2.5	23	1.3	nnw.	21.2	......
6.03 p. m...	715.9	21.1	50	nnw.	7.6	3,259	516.3	4.6	26	1.7	nnw.	21.1	615
6.17 p. m...	715.9	20.8	52	nw.	8.0	2,445	570.0	8.4	19	1.6	nnw.	15.3	425
6.26 p. m...	715.9	20.7	52	nw.	7.2	2,198	587.2	8.7	17	1.5	nnw.	14.5	380
6.28 p. m...	715.9	20.6	52	nw.	7.2	2,061	597.1	7.8	16	1.3	nnw.	14.5	350
6.32 p. m...	716.0	20.6	52	nw.	7.6	1,890	609.6	8.9	19	1.6	nnw.	16.5	330
6.55 p. m...	716.0	20.0	53	nw.	8.0	1,379	647.9	12.2	55	5.9	nw.	20.4	0
7.06 p. m...	716.0	20.0	52	nw.	9.4	913	684.5	16.6	57	8.0	nw.	17.8	0
7.18 p. m...	716.1	19.9	52	nw.	9.4	526	716.1	19.9	52	8.8	nw.	9.4	......

July 27, 1912.—Eighth flight: Five kites were used; lifting surface, 32.0 sq. m. Wire out, 4,800 m.; at maximum altitude, 4,100 m.

There were a few Ci.-St. on the northeastern horizon about 2.10 p. m.

Ninth flight: Five kites were used; lifting surface, 39.8 sq. m. Wire out, 5,500 m.; at maximum altitude, 5,200 m.

The sky was cloudless.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.								
	Pressure.	Temperature.	Rel. hum.	Wind.		Alt.	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
July 27, 1912: *Tenth flight*—	mm.	C.	%		m. p. s.	m.	mm.	C.	%	g/cu.m.		m. p. s.	Volts.
7.50 p. m.	716.3	19.7	52	nnw.	10.7	526	716.3	19.7	52	8.8	nnw.	10.7	......
8.04 p. m.	716.3	19.6	52	nnw.	10.7	900	685.9	18.2	55	8.5	nnw.	20.4	0
8.22 p. m.	716.5	19.2	53	nnw.	9.8	1,457	642.9	14.2	67	8.1	nnw.	18.9	0
8.28 p. m.	716.5	19.1	54	nnw.	9.8	1,798	617.4	13.2	52	5.9	nnw.	18.8	240
8.37 p. m.	716.6	18.8	56	nnw.	10.7	2,059	598.7	15.3	26	3.4	nnw.	11.9	380
8.52 p. m.	716.7	18.9	55	nnw.	9.8	2,580	563.1	11.9	18	1.9	nnw.	9.2	515
9.35 p. m.	717.0	19.0	54	wnw.	8.5	3,108	528.5	8.0	18	1.5	nnw.	12.8	540
9.43 p. m.	717.0	18.8	55	wnw.	7.6	3,413	508.7	5.8	24	1.7	nnw.	13.7	......
10.06 p. m.	717.1	18.1	59	wnw.	6.7	2,830	545.1	8.2	29	2.4	nnw.	11.5	425
10.23 p. m.	717.1	17.6	62	wnw.	5.4	2,206	587.5	11.1	21	2.1	nnw.	11.7	170
10.36 p. m.	717.2	17.5	63	wnw.	5.8	1,859	612.4	11.8	16	1.7	nnw.	14.0	170
10.40 p. m.	717.2	17.4	64	wnw.	5.8	1,553	635.2	10.2	24	2.3	nnw.	17.1	0
10.54 p. m.	717.2	17.0	68	wnw.	5.4	955	682.0	15.0	59	7.5	nw.	12.2	0
11.07 p. m.	717.2	16.8	69	wnw.	5.4	526	717.2	16.8	69	9.8	wnw.	5.4	......
Eleventh flight—													
11.40 p. m.	717.2	17.6	65	wnw.	7.2	526	717.2	17.6	65	9.7	wnw.	7.2	......
11.42 p. m.	717.2	17.6	64	wnw.	7.2	607	710.5	18.3	67	10.4	nw.	12.4	0
11.50 p. m.	717.2	17.6	63	wnw.	5.8	951	682.6	16.3	66	9.1	nnw.	12.4	0
July 28, 1912:													
12.06 a. m.	717.2	17.4	66	wnw.	5.8	1,382	648.7	13.3	74	8.5	nnw.	15.2	260
12.17 a. m.	717.3	17.2	66	wnw.	4.9	1,948	606.7	13.8	34	4.0	nnw.	11.2	300
12.31 a. m.	717.3	16.8	70	wnw.	4.5	2,285	583.1	12.8	24	2.7	nnw.	11.2	330
1.15 a. m.	717.4	16.6	69	wnw.	4.9	2,303	581.9	12.0	17	1.8	nnw.	11.9	260
1.19 a. m.	717.4	16.4	70	wnw.	4.0	2,799	548.1	9.5	24	2.2	nnw.	11.9	......
1.31 a. m.	717.4	16.2	70	wnw.	4.9	2,016	601.7	13.1	29	3.3	nnw.	7.8	......
1.37 a. m.	717.4	16.2	72	wnw.	5.4	1,584	633.3	13.3	26	3.0	nnw.	13.4	......
1.40 a. m.	717.4	16.2	72	wnw.	5.4	1,366	650.0	13.4	37	4.3	nnw.	15.6	......
1.48 a. m.	717.4	15.8	73	wnw.	5.4	688	703.9	16.8	60	8.5	nw.	....	......
1.49 a. m.	717.4	15.8	73	wnw.	5.4	526	717.4	15.8	73	9.7	wnw.	5.4	......
July 29, 1912: *First flight*—													
11.50 a. m.	709.0	21.1	81	w.	13.4	526	709.0	21.1	81	14.8	w.	13.4	......
11.59 a. m.	708.9	21.4	80	w.	13.4	828	684.7	20.0	78	13.4	wnw.	19.4	0
12.01 p. m.	708.9	21.6	79	wnw.	13.4	996	671.4	19.3	78	12.8	wnw.	21.2	0
12 07 p. m.	708.9	22.3	78	w.	14.3	1,202	655.7	20.9	55	9.9	wnw.	18.4	0
12.16 p. m.	708.9	22.9	76	wnw.	14.3	1,482	635.0	20.4	56	9.8	wnw.	16.2	0
12.23 p. m.	708.9	23.0	72	w.	15.2	1,640	623.5	18.6	57	9.0	wnw.	15.3	0
12.44 p. m.	708.8	23.6	72	w.	13.4	2,513	562.4	11.1	56	5.6	wnw.	17.8	0
1.00 p. m.	708.8	24.2	72	w.	13.4	3,515	497.3	1.8	54	3.0	wnw.	24.5	460
1.13 p. m.	708.8	24.6	69	w.	12.5	3.224	514.6	3.2	37	2.2	w.	....	350
1.33 p. m.	708.7	24.9	65	w.	10.7	2,321	574.6	9.8	58	5.3	wnw.	....	0
1.52 p. m.	708.7	25.1	64	w.	9.4	1,960	599.5	12.2	69	7.4	wnw.	....	170
2.10 p. m.	708.7	25.4	61	w.	9.4	1.423	638.9	14.4	88	10.8	w.	....	0
2.24 p. m.	708.6	25.7	64	w.	8.5	777	688.6	21.6	74	13.9	wnw.	7.6	0
2.30 p. m.	708.6	25.6	64	w.	7.6	526	708.6	25.6	64	15.1	w	7.6	......

July 27, 1912.—Tenth flight: Six kites were used; lifting surface, 39.8 sq. m. Wire out, 5,500 m.; at maximum altitude, 4,700 m.

The sky was cloudless.

July 28, 1912.—Eleventh flight: Five kites were used; lifting surface, 34.0 sq. m. Wire out, 3,700 m.; at maximum altitude, 3,100 m.

The sky was cloudless.

July 29, 1912.—First flight: Five kites were used; lifting surface, 30.6 sq. m. Wire out 5,000 m., at maximum altitude.

There were 5/10 to 1/10 A.-Cu. and few to 2/10 Cu. from the west-northwest before 2 p. m., then there were 3/10 Cu. from the west; the altitude of the Cu. was about 1,800 m.

At 8 a. m. low pressure (750 mm.) was central over the upper St. Lawrence Valley and high pressure (764 mm.) was central over Colorado.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Alt.	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
July 29, 1912:													
Second flight—	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%	*g/cu.m.*		*m. p. s.*	*Volts.*
3.03 p. m.	708.4	25.0	67	w.	7.6	526	708.4	25.0	67	15.3	w.	7.6	......
3.16 p. m.	708.4	24.6	70	w.	6.7	713	693.5	23.1	69	14.1	w.	8.7	0
3.41 p. m.	708.4	25.9	64	w.	8.9	1,628	624.0	15.6	84	11.1	w.	18.9	0
4.01 p. m.	708.4	25.0	64	w.	10.3	2,316	574.9	9.6	83	7.6	w.	18.9	260
4.03 p. m.	708.4	25.0	64	w.	10.3	2,388	569.9	10.3	70	6.6	w.	18.9	260
4 05 p. m.	708.4	25.1	64	w.	8.9	2,425	567.4	9.6	72	6.6	w.	20.4	270
4.40 p. m.	708.3	25.6	64	w.	8.9	2,770	544.4	6.2	63	4.6	w.	22.4	425
5.05 p. m.	708.2	25.4	62	w.	6.7	3,227	514.5	3.6	31	1.9	w.	22.4	550
5.25 p. m.	708.2	25.4	64	w.	5.4	3,440	500.5	1.6	48	2.6	w	21.4	......
5.41 p. m.	708.1	24.7	64	w.	6.3	2,907	533.6	4.4	46	3.0	wnw.	22.4	380
6.05 p. m.	708.1	24.2	64	w.	5.8	2,156	584.8	7.3	87	6.8	w.	19.2	0
6.08 p. m.	708.1	24.1	64	w.	5.8	2,173	583.6	10.2	51	4.8	w.	21.3	0
6.10 p. m.	708.1	24.0	64	w.	5.8	2,085	589.8	7.9	94	7.7	w.	21.3	0
6.20 p. m.	708.1	23.6	64	wnw.	8.9	1,430	633.0	13.3	79	9.1	w.	18.4	0
6.33 p. m.	708.2	23.5	63	wnw.	8.9	928	676.2	19.5	65	10.8	wnw.	18.9	0
6.37 p. m.	708.2	23.4	62	wnw.	11.2	526	708.2	23.4	62	12.9	wnw.	11.2	......
Third flight—													
7.09 p. m.	708.2	22.6	56	wnw.	13.4	526	708.2	22.6	56	11.1	wnw.	13.4	......
7.22 p. m.	708.3	21.8	64	nw.	11.2	906	678.0	19.6	77	12.9	nw.	19.4	0
7.41 p. m.	708.3	21.2	66	wnw.	10.3	1,416	638.8	16.2	77	10.5	nw.	18.4	0
7.52 p. m.	708.4	21.0	67	wnw.	8.9	2,045	593.1	12.1	72	7.7	nw.	22.4	170
8.26 p. m.	708.6	20.4	72	wnw.	8.9	2,546	558.6	8.1	73	6.0	nw.	23.5	170
8.55 p. m.	708.8	20.2	74	wnw.	8.9	3,495	497.1	3.4	23	1.4	nw.	25.5	......
9.26 p. m.	708.8	19.6	79	wnw.	11.2	2,600	553.8	7.0	58	4.5	nw.	23.5	0
9.51 p. m.	708.8	19.6	79	wnw.	11.6	2,174	583.2	9.4	49	4.4	nw.	25.5	170
10.01 p. m.	708.8	19.5	78	wnw.	12.1	1,720	615.8	11.6	45	4.6	nw.	22.3	230
10.04 p. m.	708.8	19.4	78	wnw.	12.1	1,582	625.9	10.4	56	5.4	nw.	22.3	260
10.12 p. m.	708.8	19.3	79	wnw.	12.1	1,479	633.6	10.8	76	7.5	nw.	21.4	170
10.28 p. m.	708.8	19.2	79	wnw.	10.7	1,008	670.0	15.2	77	9.9	nw.	21.4	0
10.39 p. m.	708.8	19.2	78	wnw.	10.7	526	708.8	19.2	78	12.7	wnw.	10.7	.....
Fourth flight—													
11.11 p. m.	708.8	18.6	81	nw.	10.7	526	708.8	18.6	81	12.8	nw.	10.7	......
11.15 p. m.	708.8	18.8	79	nw.	10.7	990	671.4	15.8	83	11.1	nw.	19.9	0
11.25 p. m.	708.8	18.6	79	nw.	9.4	1,533	629.9	14.4	72	8.8	wnw.	19.9	170
11.34 p. m.	708.8	18.5	79	nw.	10.7	1,705	617.2	14.6	46	5.7	wnw.	23.1	170
11.44 p. m.	708.8	18.4	78	nw.	12.1	1,911	602.0	13.2	53	6.0	wnw.	20.4	170
11.58 p. m.	708.8	17.8	82	nw.	11.6	2,605	554.0	8.2	48	4.0	wnw.	23.5	170
July 30, 1912:													
12.15 a. m.	708.8	17.7	82	nw.	12.5	3,138	519.4	5.6	23	1.6	wnw.	17.2	260
12.33 a. m.	708.9	17.4	84	nw.	15.2	3,775	479.0	−0.6	18	0.8	wnw.	26.5	260
1.03 a. m.	708.9	17.2	80	nw.	12.1	2,810	538.4	4.0	22	1.4	wnw.	23.5	260
1.21 a. m.	709.0	16.9	81	nw.	11.6	2,069	589.5	7.8	49	4.0	wnw.	23.5	330
1.30 a. m.	709.0	16.7	82	nw.	9.4	1,858	604.5	9.7	45	4.1	wnw.	21.1	290
1.34 a. m.	709.0	16.7	82	nw.	9.8	1,654	619.7	6.8	64	4.9	wnw.	21.1	220
1.42 a. m.	709.0	16.6	82	nw.	11.6	1,518	629.9	7.4	92	7.3	nw.	18.9	170
2.01 a. m.	709.1	16.2	82	nw.	8.9	986	671.4	11.0	89	8.8	nw.	16.8	0
2.14 a. m.	709.1	16.2	83	nw.	6.3	526	709.1	16.2	83	11.3	nw.	6.3	......

July 29, 1912.—Second flight: Five kites were used; lifting surface, 31.5 sq. m. Wire out, 5,800 m.; at maximum altitude, 5,600 m.

There were 8/10 to 1/10 Cu. and 1/10 to 2/10 Cu.-Nb. from the west, before 5 p. m. Then there were 2/10 to 1/10 St.-Cu. from the west and 2/10 Cu. from the west-northwest until 6 p. m., followed by 7/10 St.-Cu. from the northwest.

Third flight: Five kites were used; lifting surface, 31.5 sq. m. Wire out, 5,800 m., at maximum altitude.

There were 9/10 to a few St.-Cu. and a few Cu., all from the northwest.

July 30, 1912.—Fourth flight: Four kites were used; lifting surface, 25.2 sq. m. Wire out, 5,800 m., at maximum altitude.

There were a few St.-Cu. from the west-northwest at 11.44 p. m. and a few to 2/10 St.-Cu. from the northwest after 1 a. m.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m. Pressure.	Temperature.	Rel. hum.	Wind. Dir.	Wind. Vel.	At different heights above sea. Alt.	Pressure.	Temperature.	Humidity. Rel.	Humidity. Abs.	Wind. Dir.	Wind. Vel.	P.D. kite and earth.
July 30, 1912:													
Fifth flight—	*mm.*	*C.*	%		*m.p.s.*	*m.*	*mm.*	*C.*	%	*g/cu.m.*		*m.p.s.*	*Volts.*
3.01 a.m.	709.2	15.6	79	nw.	10.7	526	709.2	15.6	79	10.4	nw.	10.7	......
3.10 a.m.	709.2	15.6	79	nw.	10.7	937	675.7	14.2	81	9.8	nw.	18.9	0
3.21 a.m.	709.2	15.6	79	nw.	11.6	1,221	653.3	13.1	74	8.4	nw.	19.9	170
3.39 a.m.	709.2	15.2	80	nw.	11.6	1,491	632.6	11.6	71	7.3	nw.	20.4	260
3.45 a.m.	709.2	15.2	80	nw.	11.6	1,942	599.5	12.1	45	4.8	nw.	23.5	460
4.00 a.m.	709.2	14.8	82	nw.	11.6	2,298	574.6	9.5	31	2.8	nw.	24.5	640
4.10 a.m.	709.2	14.6	84	nw.	9.4	2,620	552.6	6.3	31	2.3	nw.	21.9	840
4.34 a.m.	709.4	14.2	85	nw.	8.9	2,834	538.0	4.7	35	2.3	nw.	16.0	......
4.52 a.m.	709.5	14.0	86	nw.	8.9	2,541	557.4	7.2	34	2.6	nw.	24.5	755
5.10 a.m.	709.5	14.1	86	wnw.	14.3	2,076	589.5	9.9	31	2.9	nw.	22.4	615
5.19 a.m.	709.5	14.1	86	wnw.	14.3	1,556	627.5	10.5	29	2.8	nw.	19.9	460
5.40 a.m.	709.5	13.9	89	wnw.	14.8	914	....	11.1	91	9.1	nw.	20.4	0
5.54 a.m.	709.5	14.0	87	wnw.	14.3	526	709.5	14.0	87	10.4	wnw.	14.3	......
Sixth flight—													
6.27 a.m.	710.0	14.2	85	wnw.	13.4	526	710.0	14.2	85	10.3	wnw.	13.4	......
6.41 a.m.	710.3	14.3	85	wnw.	13.4	866	682.2	11.9	90	9.5	nw.	17.8	260
6.45 a.m.	710.4	14.4	84	nw.	13.0	900	679.5	12.8	77	8.6	nnw.	17.7	280
6.55 a.m.	710.6	14.4	84	nw.	9.4	1,435	637.7	10.1	80	7.5	nnw.	17.3	515
7.11 a.m.	710.8	14.6	84	nw.	9.4	2,389	568.6	7.2	41	3.2	nnw.	18.4	890
7.24 a.m.	710.9	14.8	84	nw.	6.3	2,498	561.2	5.9	32	2.3	nnw.	15.8	1,170
7.50 a.m.	711.1	15.2	79	w.	3.1	2,859	537.2	4.1	27	1.7	nnw.	17.7	1,140
8.15 a.m.	711.1	16.0	81	wnw.	6.3	3,478	497.3	1.2	33	1.7	nnw.	17.2	......
8.32 a.m.	711.1	16.4	78	wnw.	5.8	2,786	541.8	3.4	43	2.6	nnw.	17.1	900
8.47 a.m.	711.1	17.1	76	wnw.	4.9	2,042	593.3	6.3	65	4.8	nnw.	22.4	540
9.05 a.m.	711.1	17.2	72	wnw.	7.6	1,260	651.9	11.0	54	5.4	nnw.	20.4	260
9.15 a.m.	711.1	17.7	70	nw.	6.7	526	711.1	17.7	70	10.5	nw.	6.7	......
Seventh flight—													
9.52 a.m.	711.0	18.5	68	nw.	9.4	526	711.0	18.5	68	10.7	nw.	9.4	......
9.58 a.m.	711.0	18.5	66	nw.	9.4	815	687.4	15.0	66	8.4	nw.	10.2	0
10.19 a.m.	711.0	18.8	68	nw.	9.4	1,379	642.9	11.4	82	8.4	nw.	19.4	170
10.35 a.m.	710.9	19.2	66	nw.	10.7	2,009	595.9	7.2	77	6.0	nw.	17.3	460
10.56 a.m.	710.9	19.4	64	nw.	8.9	2,763	543.5	2.4	65	3.7	nw.	14.3	640
11.06 a.m.	710.9	19.8	62	wnw.	11.2	2,836	538.6	1.5	71	3.8	nw.	13.8	730
11.07 a.m.	710.9	19.8	62	wnw.	11.2	2,944	531.4	2.3	60	3.4	nw.	13.8	750
11.11 a.m.	710.9	19.9	62	nw.	9.4	3,272	510.4	1.6	48	2.6	nw.	13.8	830
11.30 a.m.	710.8	19.9	60	nw.	8.9	3,624	488.5	−0.8	38	1.7	nw.	16.3	840
11.55 a.m.	710.8	20.6	60	nw.	8.9	3,750	480.5	−1.0	32	1.4	nw.	16.3	835
12.00 m.	710.8	20.3	62	nw.	9.4	3,590	489.5	−1.5	34	1.5	nw.	16.9	810
12.10 p.m.	710.8	20.3	63	wnw.	8.9	3,112	519.7	0.3	40	2.0	nw.	15.3	590
12.24 p.m.	710.8	20.2	61	wnw.	8.9	2,966	529.2	1.6	50	2.7	nw.	14.9	610
12.25 p.m.	710.8	20.2	61	wnw.	8.9	2,860	536.2	−0.1	58	2.8	nw.	15.9	550
12.34 p.m.	710.7	20.2	59	wnw.	9.4	2,538	557.9	1.8	94	5.1	nw.	15.2	640
12.35 p.m.	710.7	20.5	59	wnw.	9.4	2,555	556.7	0.3	84	4.2	nw.	16.8	640
12.40 p.m.	710.7	21.0	56	wnw.	10.3	2,538	557.9	1.4	64	3.4	nw.	15.7	640
12.48 p.m.	710.7	21.8	53	wnw.	10.7	2,022	594.7	4.4	83	5.4	nw.	17.3	810
1.03 p.m.	710.7	21.2	57	wnw.	10.7	1,313	648.0	10.4	80	7.6	wnw.	15.8	0
1.15 p.m.	710.7	22.2	67	wnw.	12.1	881	682.1	16.3	63	8.7	wnw.	15.8	0
1.27 p.m.	710.7	22.1	54	wnw.	11.6	526	710.7	22.1	54	10.4	wnw.	11.6	......

July 30, 1912.—Fifth flight: Four kites were used; lifting surface, 25.2 sq. m. Wire out, 5,800 m.; at maximum altitude, 5,400 m.

The sky was cloudless until 4.20 a. m.; then there were few to 3/10 St.-Cu. from the northwest.

Sixth flight: Five kites were used; lifting surface, 30.6 sq. m. Wire out, 5,800 m.; at maximum altitude, 5,200 m.

There was light haze; also few to 1/10 St.-Cu. from the northwest.

At 8 a. m. low pressure (752 mm.) was central off the New England coast and high pressure (766 mm.) was central over the Dakotas.

Seventh flight: Six kites were used; lifting surface, 37.8 sq. m. Wire out, 5,850 m., at maximum altitude.

Cu. from the northwest increased from few to 8/10 by noon and thereafter decreased to 5/10.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Alt.	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
July 30, 1912: *Eighth flight*—	*mm.*	*C.*	*%*		*m. p. s.*	*m.*	*mm.*	*C.*	*%*	*g/cu. m.*		*m. p. s.*	*Volts.*
2.04 p. m.	710.6	22.4	51	nw.	12.1	526	710.6	22.4	51	10.0	nw.	12.1	......
2.15 p. m.	710.6	22.4	50	nw.	11.2	774	690.6	19.3	53	8.7	nw.	15.3	0
3.48 p. m.	710.8	22.8	51	wnw.	8.9	1,126	663.0	16.8	59	8.4	nw.	12.8	0
4.18 p. m.	710.8	2.22	51	wnw.	8.9	1,432	639.6	13.8	73	8.6	wnw.	11.2	0
4.41 p. m.	710.9	21.9	56	wnw.	7.2	1,893	605.2	9.1	73	6.4	wnw.	14.8	0
4.55 p. m.	710.9	21.4	59	wnw.	4.5	2,027	595.2	7.3	82	6.4	wnw.	14.3	......
4.59 p. m.	710.9	21.3	59	wnw.	4.0	2,005	596.5	7.4	91	7.2	wnw.	.....	......
5.03 p. m.	710.9	21.4	57	wnw.	4.0	1,664	621.7	9.7	81	7.4	wnw.	15.3	......
5.13 p. m.	710.9	21.6	57	wnw.	5.4	1,058	668.2	14.9	65	8.2	wnw.	9.0	......
5.22 p. m.	710.9	21.8	57	wnw.	4.5	526	710.9	21.8	57	10.8	wnw.	4.5	......
Aug. 1, 1912:													
3.58 p. m.	714.4	21.2	47	w.	6.7	526	714.4	21.2	47	8.6	w.	6.7	......
4.08 p. m.	714.4	21.2	48	w.	7.2	869	686.6	17.7	49	7.3	w.	10.2	0
4.38 p. m.	714.4	21.0	50	w.	7.2	1,152	664.2	14.9	55	7.0	w.	9.7	0
5.20 p. m.	714.5	20.3	54	w.	8.0	1,624	628.1	11.3	46	4.7	w.	8.0	0
6.08 p. m.	714.7	19.0	55	wnw.	8.0	1,994	600.4	7.5	42	3.3	w.	5.3	0
6.22 p. m.	714.8	18.6	57	wnw.	7.6	1,673	624.3	8.9	48	4.2	w.	10.0	0
6.28 p. m.	714.8	18.6	56	wnw.	8.0	1,285	653.8	11.8	58	6.1	wnw.	9.5	0
6.40 p. m.	714.9	18.1	57	wnw.	8.0	906	683.9	15.2	51	6.6	w.	11.2	0
6.47 p. m.	715.0	18.0	57	wnw.	8.0	526	715.0	18.0	57	8.7	wnw.	8.0	......
Aug. 3, 1912:													
9.36 a. m.	716.6	13.4	73	wnw.	10.3	526	716.6	13.4	73	8.4	wnw.	10.3	......
9.54 a. m.	716.7	14.2	74	nw.	10.3	911	684.6	9.0	87	7.6	nw.	14.3	......
10.12 a. m.	716.8	14.5	68	wnw.	8.9	1,203	661.0	7.1	84	6.5	nw.	18.8	615
10.20 a. m.	716.7	14.7	62	wnw.	9.4	1,498	637.8	10.3	44	4.2	nw.	15.3	750
10.34 a. m.	716.7	15.1	65	wnw.	9.4	1,751	618.7	10.0	28	2.6	nw.	12.9	810
10.43 a. m.	716.7	15.2	67	wnw.	10.7	2,654	554.6	4.8	19	1.3	wnw.	19.9	1,150
11.00 a. m.	716.6	14.8	67	wnw.	10.3	3,501	499.4	−0.7	15	0.7	wnw.	29.3	1,880
11.21 a. m.	716.7	14.9	66	wnw.	11.2	4,312	450.1	−5.8	15	0.5	wnw.	29.8	......
11.48 a. m	716.8	15.4	65	wnw.	10.3	3,602	491.5	−3.1	13	0.5	wnw.	23.5	1,550
12.02 p. m.	716.9	15.4	64	wnw.	11.2	2,917	535.5	−0.5	14	0.7	wnw.	21.4	1,400
12.20 p. m.	716.9	15.6	67	wnw.	8.0	2,119	591.3	4.5	13	0.8	wnw.	13.8	640
12.26 p. m.	716.9	15.6	64	wnw.	9.8	1,647	626.3	6.2	13	1.0	nw.	14.4	500
12.33 p. m.	717.0	15.6	64	wnw.	8.0	1,417	644.2	4.4	68	4.4	nw.	16.3	425
12.43 p. m.	717.0	15.6	64	wnw.	8.9	883	687.3	9.7	76	7.0	wnw.	11.7	0
12.51 p. m.	717.0	15.2	66	wnw.	7.6	526	717.0	15.2	66	8.5	wnw.	7.6	......

July 30, 1912.—Eighth flight: Four kites were used; lifting surface, 25.2 sq. m. Wire out, 3,000 m.; at maximum altitude, 2,650 m.

There were 3/10 to 8/10 Cu. from the northwest.

August 1, 1912.—Five kites were used; lifting surface, 38.4 sq. m. Wire out, 4,500 m.; at maximum altitude, 3,800 m.

Cu. from the west decreased from 3/10 to a few.

At 8 a. m. low pressure (757 mm.) was central off the southern coast of Massachusetts. High pressure (767 mm.) was central over North Dakota.

August 3, 1912.—Six kites were used; lifting surface, 37.8 sq. m. Wire out, 5,500 m.; at maximum altitude, 5,300 m.

A.-Cu. and A.-St., from the west, and Cu. from the northwest, covered the sky. The head kite was in Cu. at 10.09 a. m., altitude 1,250 m.

High pressure (772 mm.) was central over Manitoba, low pressure (755 mm.) over New Hampshire.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Alt.	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
Aug. 19, 1912:													
First flight—	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%	*g/cu.m.*		*m. p. s.*	*Volts.*
7.13 a. m.	715.6	23.2	73	w.	8.0	526	715.6	23.2	73	15.0	w.	8.0	......
7.25 a. m.	715.6	23.6	74	w.	8.9	973	680.0	21.6	81	15.2	wnw.	12.9	0
7.30 a. m.	715.6	23.9	72	w.	8.9	1,251	658.7	21.8	67	12.7	wnw.	14.0	0
7.34 a. m.	715.5	24.2	71	w.	9.4	1,556	635.9	21.0	57	10.3	wnw.	11.9	0
7.48 a. m.	715.5	23.7	75	w.	10.3	1,889	611.9	19.9	46	7.8	wnw.	11.2	0
8.11 a. m.	715.5	23.2	78	wnw.	11.2	2,277	585.0	16.6	41	5.7	wnw.	9.2	170
8.30 a. m.	715.5	23.6	80	w.	10.7	2,993	537.1	9.0	61	5.3	w.	9.9	0
8.52 a. m.	715.5	23.4	79	w.	8.9	3,869	482.5	0.8	85	4.3	w.	15.2	0
9.11 a. m.	715.5	24.6	76	w.	6.3	3,228	521.3	5.9	55	3.9	w.	16.5	0
9.34 a. m.	715.5	25.2	71	w.	6.3	2,460	571.7	12.6	59	6.5	w.	11.9	0
9.49 a. m.	715.5	25.4	73	w.	7.6	1,991	604.1	16.0	57	7.7	w.	21.4	0
10.03 a. m.	715.5	25.8	71	w.	7.6	1,525	638.0	18.4	73	11.4	w.	15.2	0
10.07 a. m.	715.5	25.8	71	w.	7.6	1,470	642.1	18.9	72	11.6	w.	14.7	0
10.09 a. m.	715.5	25.8	71	w.	6.7	1,387	648.2	18.2	88	13.6	w.	20.3	0
10.20 a. m.	715.5	26.2	72	w.	5.8	890	686.5	21.2	78	14.3	w.	9.2	0
10.25 a. m.	715.5	26.3	70	w.	5.4	526	715.5	26.3	70	17.2	w.	5.4	......
Second flight—													
11.23 a. m.	715.3	27.2	68	wsw.	5.8	526	715.3	27.2	68	17.5	wsw.	5.8	......
11.33 a. m.	715.3	26.9	67	wsw.	6.3	789	694.4	24.5	69	15.3	wsw.	7.1	0
12.52 p. m.	714.8	27.5	66	w.	5.4	1,162	665.2	22.5	75	14.8	w.	9.7	0
1.15 p. m.	714.6	28.1	61	w.	8.9	1,751	621.2	17.9	83	12.6	wnw.	16.8	0
1.30 p. m.	714.6	27.5	56	w.	9.8	2,070	598.4	16.3	77	10.6	wnw.	16.8	0
2.06 p. m.	714.4	26.0	63	wnw.	8.9	2,752	551.6	10.4	79	7.6	wnw.	17.3	......
2.24 p. m.	714.3	25.8	66	w.	7.6	3,306	515.8	6.4	71	5.3	w.	17.3	......
2.31 p. m.	714.3	25.5	64	n.	7.6	3,679	492.5	3.1	75	4.5	w.	19.4	......
2.45 p. m.	714.3	25.4	64	n.	5.8	3,291	515.8	5.3	73	5.0	w.	16.2	......
3.03 p. m.	714.2	25.4	67	wnw.	6.7	2,663	556.4	10.1	59	5.5	w.	18.4	0
3.30 p. m.	714.1	26.3	68	w.	6.3	2,087	595.9	13.6	58	6.8	wnw.	16.8	0
3.48 p. m.	714.0	26.2	72	nw.	6.7	1,248	657.4	19.2	60	9.8	w.	16.8	0
4.06 p. m.	713.8	26.0	72	w.	4.9	922	682.4	22.3	65	12.7	w.	12.2	0
4.11 p. m.	713.8	26.4	68	w.	4.0	526	713.8	26.4	68	16.8	w.	4.0	......
Third flight—													
4.47 p. m.	713.4	26.6	64	w.	4.9	526	713.4	26.6	64	16.0	w.	4.9	......
5.09 p. m.	713.3	25.8	68	w.	4.9	929	681.4	23.6	71	15.0	w.	10.7	0
5.24 p. m.	713.3	25.6	68	wnw.	6.7	1,236	657.8	21.0	80	14.5	wnw.	13.8	0
5.42 p. m.	713.4	25.0	71	wnw.	7.6	1,862	611.7	15.4	96	12.5	wnw.	16.8	0
5.55 p. m.	713.4	24.9	71	n.	5.8	2,251	584.3	13.5	78	9.1	wnw.	15.8	0
5.59 p. m.	713.4	24.1	72	nw.	6.7	2,533	564.7	10.8	88	8.6	wnw.	17.8	0
6.05 p. m.	713.4	23.0	74	nw.	8.0	2,174	589.3	12.6	76	8.3	wnw.	13.8	0
6.24 p. m.	713.6	20.2	94	nw.	5.8	1,575	632.0	15.0	75	9.5	wnw.	13.8	0
6.26 p. m.	713.7	20.2	93	nw.	5.8	1,783	616.8	14.4	84	10.3	wnw.	17.3	0
6.33 p. m.	713.7	20.6	91	nw.	6.7	1,541	634.6	15.8	86	11.5	wnw.	13.2	0

August 19, 1912.—First flight: Six kites were used; lifting surface, 37.8 sq. m. Wire out, 5,500 m., at maximum altitude.

There were 6/10 to 8/10 Ci.-St., A.-Cu., A.-St. and St.-Cu. all from the west.

At 8 a. m. high pressure (766 mm.) was central over Alabama; low pressure was central over Minnesota (754 mm.) and over the lower St. Lawrence Valley (756 mm.)

Second flight: Five kites were used; lifting surface, 34.5 sq. m. Wire out, 5,500 m., at maximum altitude.

There were 8/10 to 9/10 Ci.-St., A.-St., A.-Cu., St.-Cu. and Cu. from the west before 1 p. m. Then there were 9/10 St.-Cu. and 1/10 Cu.-Nb. from the west-northwest, and after 3 p. m. 9/10 St.-Cu. from the west. Light rain fell from 2.35 to 3.25 p. m. The head kite was in the clouds at 1.15 and 1.23 p. m., altitude 1,700 m.

Third flight: Six kites were used; lifting surface, 40.3 sq. m. Wire out, 5,500 m.; at maximum altitude, 5,200 m.

At the beginning of the flight there were 6/10 A.-St., 1/10 A.-Cu. and 1/10 St.-Cu. from the west; after 5.30 p. m. St.-Cu. from the west-northwest covered the sky. The head kite was in St.-Cu. at 5.38, from 5.55 to 6.21, and at 6.49 p. m., altitude about 2,000 m.

There was light rain from 6.04 to 6.21 and from 8.32 to 8.42 p. m.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m. Pressure.	Temperature.	Rel. hum.	Wind. Dir.	Wind. Vel.	At different heights above sea. Alt.	Pressure.	Temperature.	Humidity. Rel.	Humidity. Abs.	Wind. Dir.	Wind. Vel.	P. D. kite and earth.
Aug. 19, 1912:													
Third flight—	mm.	C.	%		m.p.s.	m.	mm.	C.	%	g/cu.m.		m.p.s.	Volts.
6.49 p.m...	713.8	20.6	91	nw.	4.5	2,098	594.2	12.4	87	9.0	wnw.	14.8	0
7.05 p.m...	714.0	20.6	91	nw.	5.8	2,787	547.7	9.4	76	6.8	wnw.	15.3	0
7.24 p.m...	714.0	20.7	90	nw.	5.8	3,440	505.5	2.8	91	5.3	wnw.	17.6	......
7.43 p.m...	714.0	21.2	88	wnw.	5.8	2,739	550.2	7.2	76	5.9	w.	19.4	0
7.55 p.m...	714.0	21.8	83	w.	5.4	2,244	584.3	10.6	73	7.1	w.	22.4	0
8.15 p.m...	713.8	22.0	82	w.	4.9	1,715	621.9	15.2	72	9.3	w.	22.4	0
8.30 p.m...	713.7	22.2	81	w.	4.0	1,234	657.8	18.4	77	12.0	w.	20.4	0
8.39 p.m...	713.6	22.6	79	w.	7.6	845	688.1	21.9	70	13.4	w.	15.8	0
8.45 p.m...	713.6	22.8	77	w.	7.2	526	713.6	22.8	77	15.5	w.	7.2	......
Fourth flight—													
9.17 p.m...	713.3	23.0	75	wsw.	7.6	526	713.3	23.0	75	15.3	wsw.	7.6	......
9.19 p.m...	713.3	23.0	75	wsw.	7.6	585	708.5	23.5	68	14.2	w.	13.9	0
9.25 p.m...	713.3	23.2	74	wsw.	6.7	888	684.4	22.2	70	13.6	w.	13.8	0
9.34 p.m...	713.3	23.1	75	wsw.	7.2	1,297	652.9	19.0	79	12.8	w.	16.3	0
9.35 p.m...	713.3	23.0	76	wsw.	7.2	1,366	647.7	19.4	75	12.4	w.	16.3	0
9.49 p.m...	713.2	23.1	73	w.	6.3	1,766	618.3	18.1	67	10.3	w.	13.3	0
9.55 p.m...	713.2	23.2	72	wnw.	5.8	1,784	617.0	18.4	60	9.4	wnw.	13.5	0
10.04 p.m..	713.2	23.0	73	wnw.	8.0	2,375	575.8	14.4	66	8.1	wnw.	15.3	0
10.18 p.m..	713.2	22.1	80	wnw.	10.3	2,716	552.7	11.7	60	6.2	wnw.	13.8	0
10.38 p.m..	713.1	22.1	78	wnw.	14.3	3,348	512.4	6.8	69	5.3	wnw.	15.3	0
10.43 p.m..	713.1	21.9	77	wnw.	13.4	3,576	497.4	4.4	68	4.4	wnw.	18.7	......
11.05 p.m..	713.1	21.6	75	wnw.	9.4	2,950	535.9	8.1	72	6.0	wnw.	15.8	0
11.24 p.m..	713.1	21.8	74	wnw.	10.3	2,229	584.5	12.1	65	6.9	wnw.	13.3	0
11.42 p.m..	713.1	21.6	76	wnw.	9.4	1,667	624.6	15.1	75	9.6	wnw.	15.8	0
Aug. 20, 1912:													
12.09 a.m..	713.1	21.6	76	wnw.	8.5	883	684.4	19.4	74	12.2	wnw.	17.3	0
12.14 a.m..	713.1	21.6	76	wnw.	8.9	649	703.1	21.8	72	13.7	wnw.	14.1	0
12.16 a.m..	713.1	21.6	76	wnw.	9.4	526	713.1	21.6	76	14.3	wnw.	9.4	......
Fifth flight—													
1.11 a.m...	713.0	21.2	78	wnw.	10.3	526	713.0	21.2	78	14.3	wnw.	10.3	......
1.18 a.m...	713.0	21.8	74	wnw.	10.7	892	683.6	19.7	86	14.5	nw.	18.4	0
1.22 a.m...	713.0	21.3	78	wnw.	9.4	1,059	670.4	18.3	92	14.3	nw.	15.1	0
1.31 a.m...	713.1	20.8	81	wnw.	11.6	1,246	656.0	19.2	86	14.1	nw.	19.4	0
1.43 a.m...	713.1	21.2	78	wnw.	15.2	1,821	613.7	17.0	78	11.2	nw.	15.3	0
1.57 a.m...	713.1	21.2	78	wnw.	11.6	2,464	568.9	13.1	82	9.3	nw.	12.8	0
2.03 a.m...	713.1	21.2	79	wnw.	13.4	2,646	556.8	11.2	84	8.5	nw.	12.2	0
2.13 a.m...	713.1	21.2	80	wnw.	11.2	3,014	532.7	7.4	98	7.8	nw.	10.2	0
2.23 a.m...	713.0	21.0	81	wnw.	10.3	3,273	516.2	5.9	98	7.0	nw.	13.3	0
2.40 a.m...	713.0	21.0	81	wnw.	13.4	3,766	485.2	2.9	84	4.9	nw.	14.4	......
2.51 a.m...	712.9	21.0	81	wnw.	10.3	3,505	500.1	5.1	76	5.2	nw.	10.8	......
2.54 a.m...	712.9	21.0	81	wnw.	10.7	3,319	511.6	4.2	96	6.2	nw.	14.9	50
2.58 a.m...	712.9	20.9	82	wnw.	10.7	3,249	516.2	4.9	94	6.3	nw.	14.4	100
3.22 a.m...	712.9	20.6	85	wnw.	10.7	2,514	564.0	9.1	82	7.2	nw.	15.1	80
3.40 a.m...	713.0	20.6	85	wnw.	9.4	1,966	602.4	11.9	78	8.2	nw.	15.3	0
3.51 a.m...	713.0	20.2	88	wnw.	7.6	1,532	634.1	15.9	76	10.2	nw.	16.8	0
3.56 a.m...	713.0	20.4	86	wnw.	6.7	1,379	645.6	16.6	76	10.6	nw.	16.3	0
4.00 a.m...	713.0	20.5	86	wnw.	8.0	1,225	657.3	16.1	74	10.1	nw.	17.9	0
4.11 a.m...	713.0	20.6	86	wnw.	9.4	890	683.6	18.1	80	13.2	nw.	18.4	0
4.19 a.m...	713.1	20.8	85	wnw.	9.4	526	713.1	20.8	85	15.2	wnw.	9.4	......

August 19, 1912.—Fourth flight: Six kites were used; lifting surface, 39.8 sq. m. Wire out, 5,500 m.; at maximum altitude, 5,400 m.

St.-Cu. probably from the west-northwest varied from 5/10 to 10/10 before 11 p. m., decreasing thereafter to few.

August 20, 1912.—Fifth flight: Six kites were used; lifting surface, 39.8 sq. m. Wire out, 5,500 m.; at maximum altitude, 5,200 m.

There were 5/10 to 2/10 St.-Cu. from the northwest.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind. Dir.	Wind. Vel.	Alt.	Pressure.	Temperature.	Humidity. Rel.	Humidity. Abs.	Wind. Dir.	Wind. Vel.	P.D. kite and earth.
Aug. 20, 1912:													
Sixth flight—	*mm.*	*C.*	*%*		*m. p. s.*	*m.*	*mm.*	*C.*	*%*	*g/cu. m.*		*m. p. s.*	*Volts.*
4.51 a. m.	713.2	20.6	86	wnw.	9.8	526	713.2	20.6	86	15.2	wnw.	9.8	......
5.13 a. m.	713.2	20.3	88	wnw.	7.2	972	677.3	18.5	94	14.7	wnw.	15.8	0
5.27 a. m.	713.2	20.4	88	wnw.	8.0	1,375	646.1	16.4	94	13.0	nw.	13.8	0
5.41 a. m.	713.3	20.4	89	wnw.	7.2	1,825	612.9	14.7	92	11.5	nw.	12.8	0
5.49 a. m.	713.3	20.8	85	wnw.	8.9	1,860	610.4	14.6	89	11.0	nw.	12.2	0
6.07 a. m.	713.3	20.8	85	wnw.	8.9	2,230	584.3	13.1	90	10.2	nw.	10.2	0
6.23 a. m.	713.3	20.4	88	wnw.	9.8	3,120	525.3	8.1	70	5.8	nw.	12.8	0
6.35 a. m.	713.3	20.4	88	wnw.	9.8	3,662	491.7	4.7	58	3.9	nw.	16.1	......
6.45 a. m.	713.3	20.5	88	wnw.	9.8	3,450	504.4	5.6	67	4.7	nw.	17.2	......
6.57 a. m.	713.3	20.8	87	wnw.	9.8	2,971	534.6	8.8	64	5.5	nw.	16.6	0
7.10 a. m.	713.3	21.0	85	wnw.	10.3	2,246	583.0	13.1	61	6.9	nw.	16.3	0
7.26 a. m.	713.4	21.0	85	wnw.	9.4	1,927	605.4	13.4	77	8.9	nw.	17.8	0
7.40 a. m.	713.4	21.0	85	wnw.	8.9	1,377	646.1	15.4	84	10.9	nw.	21.4	0
7.51 a. m.	713.5	21.1	84	wnw.	10.3	942	680.0	17.8	92	13.8	nw.	19.4	0
8.00 a. m.	713.5	21.4	85	wnw.	9.4	526	713.5	21.4	85	15.8	wnw.	9.4	......
Seventh flight—													
8.32 a. m.	713.6	22.4	82	wnw.	6.7	526	713.6	22.4	82	16.1	wnw.	6.7	......
8.48 a. m.	713.6	22.3	82	wnw.	7.6	852	687.4	19.4	94	15.5	wnw.	13.3	0
8.57 a. m.	713.6	22.9	81	wnw.	7.6	1,426	643.0	16.9	90	12.8	wnw.	15.8	0
9.14 a. m.	713.6	23.0	78	wnw.	9.4	1,912	607.4	15.1	76	9.7	nw.	19.9	0
9.15 a. m.	713.6	22.9	78	wnw.	9.4	1,946	604.9	15.8	72	9.6	nw.	19.9	0
9.22 a. m.	713.6	22.8	78	wnw.	8.9	2,035	598.6	15.6	64	8.4	nw.	15.1	0
9.35 a. m.	713.6	23.0	78	wnw.	10.3	2,592	560.6	13.0	56	6.3	nw.	16.8	0
9.48 a. m.	713.6	22.8	78	wnw.	10.7	3,296	515.4	8.7	42	3.6	nw.	18.9	0
10.00 a. m.	713.6	23.3	75	wnw.	9.8	3,948	476.5	3.7	42	2.6	nnw	23.5	0
10.21 a. m.	713.6	23.8	72	wnw.	13.4	4,088	467.4	0.9	58	3.0	nnw	22.4	0
10.38 a. m.	713.7	23.8	72	wnw.	12.1	3,319	513.1	6.3	58	4.3	nnw	18.1	0
10.56 a. m.	713.7	23.9	73	wnw.	12.1	2,564	561.8	12.3	38	4.1	nnw	15.8	0
11.02 a. m.	713.7	23.5	73	nw.	8.9	2,225	585.0	14.5	40	4.9	nw.	18.9	0
11.07 a. m.	713.7	23.4	73	nw.	11.2	2,027	598.6	12.6	46	5.1	nw.	20.4	0
11.10 a. m.	713.7	23.4	73	nw.	8.9	1,939	604.9	14.2	62	7.5	nw.	20.4	0
11.14 a. m.	713.7	23.5	73	nw.	8.9	1,836	612.4	12.4	64	7.1	nw.	18.5	0
11.25 a. m.	713.6	23.6	74	nw.	7.6	1,355	648.2	15.0	54	6.9	nw.	20.4	0
11.38 a. m.	713.6	24.3	71	nw.	7.6	870	686.1	19.9	55	9.4	nw.	12.8	0
11.44 a. m.	713.6	25.2	69	wnw.	8.0	526	713.6	25.2	69	15.9	wnw.	8.0	......
Eighth flight—													
12.14 p. m.	713.5	25.0	70	nw.	7.2	526	713.5	25.0	70	16.0	nw.	7.2	......
12.25 p. m.	713.5	24.4	70	wnw.	7.6	895	684.0	20.9	76	13.6	nw.	13.8	0
12.58 p. m.	713.4	24.2	69	wnw.	8.0	1,352	648.6	18.3	77	11.9	nw.	16.8	0
1.04 p. m.	713.4	24.0	70	wnw.	9.4	1,402	644.8	17.6	76	11.3	nw.	17.5	0
1.06 p. m.	713.4	23.9	70	wnw.	8.9	1,576	631.9	18.8	71	11.3	nw.	15.8	0
1.08 p. m.	713.4	23.9	70	wnw.	8.9	1,857	611.6	16.8	65	9.2	nw.	18.9	0
1.17 p. m.	713.4	24.5	69	wnw.	8.9	2,104	594.1	13.0	81	9.1	nw.	19.0	0
1.20 p. m.	713.4	24.7	69	wnw.	9.4	2,261	583.4	14.8	59	7.4	nw.	14.5	0
1.25 p. m.	713.4	25.1	68	wnw.	7.2	2,140	591.7	11.3	92	9.3	nw.	17.6	0

August 20, 1912.—Sixth flight: Six kites were used; lifting surface, 39.8 sq. m. Wire out, 5,500 m.; at maximum altitude, 5,300 m.

There were 4/10 to 8/10 Ci., Ci.-St. and St.-Cu. from the northwest before 7 a. m.; thereafter there were 8/10 Ci.-St. from the northwest.

At 8 a. m. high pressure (764 mm.) was central over the South Atlantic and Gulf States. Low pressure (756 mm.) was central over Connecticut.

Seventh flight: Five kites were used; lifting surface, 33.5 sq. m. Wire out, 5,500 m., at maximum altitude.

The sky was covered with Ci.-St. and Cu. from the northwest before 10 a. m.; thereafter 9/10 Ci.-St., Cu. and St.-Cu. from the northwest. The head kite was in Cu. at 9.11 a. m., altitude about 1,750 m., and at 11.12 a. m. in St.-Cu., altitude about 1,950 m.

Eighth flight: Five kites were used; lifting surface, 33.5 sq. m. Wire out, 5,600 m., at maximum altitude.

There were 9/10 St.-Cu. from the northwest before 3 p. m.; then there were 10/10 St.-Cu. from the west-northwest. The head kite was in St.-Cu. from 1.23 to 1.46 p. m., altitude about 2,200 m., and from 1.50 to 2.29 p. m., altitude about 2,900 m.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Alt.	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
Aug. 20, 1912:													
Eighth flight—	*mm.*	*C.*	*%*		*m. p. s.*	*m.*	*mm*	*C.*	*%*	*g/cu. m.*		*m. p. s.*	*Volts.*
1.27 p. m.	713.4	25.3	68	wnw.	5.8	2,285	581.7	9.8	94	8.7	nw.	13.3	0
1.28 p. m.	713.4	25.4	69	wnw.	5.8	2,567	562.2	11.3	73	7.4	nw.	20.4	0
1.51 p. m.	713.4	26.3	69	wnw.	5.8	2,974	535.7	7.7	85	6.8	nw.	16.9	......
2.02 p. m.	713.4	26.3	65	nw.	5.8	3,819	482.4	2.3	63	3.6	nw.	21.4	......
2.15 p. m.	713.4	25.8	66	nw.	5.8	3,582	496.1	3.9	53	3.3	nw.	21.2	0
2.32 p. m.	713.3	25.2	67	nw.	6.7	2,837	543.0	7.0	84	6.5	nw.	18.4	0
2.51 p. m.	713.3	24.7	68	wnw.	7.6	2,406	571.9	9.7	79	7.2	nw.	18.3	0
2.52 p. m.	713.3	24.7	69	wnw.	7.6	2,230	584.2	9.2	79	7.0	nw.	18.3	0
2.59 p. m.	713.3	24.5	63	wnw.	7.2	2,054	596.6	10.2	77	7.3	nw.	17.3	0
3.09 p. m.	713.3	24.1	67	wnw.	8.0	1,469	639.6	14.7	76	9.5	nw.	14.8	0
3.21 p. m.	713.3	23.8	67	wnw.	8.9	909	682.6	20.0	68	11.6	nw.	15.3	0
3.30 p. m.	713.3	23.6	68	wnw.	8.5	526	713.3	23.6	68	14.3	wnw.	8.5	......
Aug. 21, 1912:													
First flight—													
8.36 a. m.	711.9	22.8	74	w.	8.9	526	711.9	22.8	74	14.9	w.	8.9	......
8.59 a. m.	711.8	23.6	72	w.	6.3	866	684.6	20.4	75	13.1	w.	12.2	0
9.14 a. m.	711.8	23.4	72	w.	6.3	1,239	655.7	19.2	68	11.1	wnw.	15.8	0
9.25 a. m.	711.8	23.7	73	w.	6.3	1,550	632.5	18.1	59	9.0	wnw.	10.2	0
9.58 a. m.	711.8	24.3	74	w.	6.7	1,812	613.4	15.4	62	8.1	wnw.	7.9	0
10.52 a. m.	711.5	25.9	65	w.	5.4	2,285	579.7	12.0	50	5.3	wnw.	7.0	......
11.11 a. m.	711.4	26.0	62	w.	7.2	1,713	619.8	14.2	75	9.1	wnw.	13.4	0
11.16 a. m.	711.3	26.1	62	w.	7.2	1,438	640.2	15.3	86	11.1	wnw.	12.4	0
11.25 a. m.	711.3	26.0	61	w.	6.7	1,028	671.4	19.0	75	12.1	wnw.	11.4	0
11.31 a. m.	711.2	25.8	62	w.	8.0	859	684.6	20.4	69	12.1	wnw.	8.7	0
11.41 a. m.	711.1	25.3	64	w.	6.7	526	711.1	25.3	64	14.8	w.	6.7	......
Second flight—													
1.39 p. m.	710.8	25.2	63	w.	8.0	526	710.8	25.2	63	14.5	w.	8.0	......
1.56 p. m.	710.7	25.2	63	w.	10.3	912	680.2	22.8	63	12.7	w.	12.8	0
2.03 p. m.	710.7	25.2	63	w.	11.2	1,303	650.2	19.5	74	12.3	w.	12.8	0
2.15 p. m.	710.6	25.0	63	w.	9.4	1,860	609.4	15.8	58	7.7	wnw.	18.4	0
2.48 p. m.	710.3	24.7	66	w.	9.4	2,190	585.8	13.5	44	5.1	wnw.	8.8	0
3.52 p. m.	709.8	25.3	66	w.	8.5	2,706	550.4	8.2	50	4.2	nw.	8.2	0
4.14 p. m.	709.8	24.3	65	wnw.	10.3	2,917	536.1	6.7	60	4.5	wnw.	9.6	......
4.31 p. m.	709.8	23.5	70	wnw.	11.2	2,506	562.6	9.8	52	4.8	wnw.	7.4	0
4.43 p. m.	709.8	23.7	69	wnw.	10.3	2,135	588.2	12.8	47	5.2	wnw.	6.3	0
5.03 p. m.	709.8	23.0	68	nw.	9.8	1,317	647.6	15.7	74	9.8	wnw.	13.3	0
5.13 p. m.	709.8	22.6	70	nw.	9.8	914	678.8	19.2	69	11.3	nw.	15.3	0
5.18 p. m.	709.8	22.6	70	nw.	9.8	526	709.8	22.6	70	13.9	nw.	9.8	......
Third flight—													
5.49 p. m.	709.7	22.5	61	wnw.	11.6	526	709.7	22.5	61	12.1	wnw.	11.6	......
5.57 p. m.	709.7	22.2	62	wnw.	11.2	911	679.0	20.9	68	12.3	wnw.	15.8	0
6.08 p. m.	709.7	22.2	61	wnw.	11.2	1,391	642.5	19.4	44	7.3	wnw.	17.3	0
6.18 p. m.	709.6	22.2	61	nw.	11.2	1,635	624.5	18.8	44	7.0	wnw.	10.2	0
6.30 p. m.	709.6	22.2	61	nw.	11.6	1,899	605.5	17.2	42	6.1	wnw.	7.6	0
6.56 p. m.	709.5	22.0	61	nw.	9.4	2,292	578.1	12.2	58	6.2	w.	9.9	0
7.35 p. m.	709.6	21.4	64	nw.	11.2	2,841	540.6	6.6	64	4.8	w.	10.5	......
7.49 p. m.	709.7	21.3	66	nw.	11.2	2,009	596.8	12.1	64	6.8	wnw.	10.2	0
8.12 p. m.	709.7	21.2	66	nw.	11.6	1,537	630.9	16.5	56	7.8	wnw.	7.5	0
8.22 p. m.	709.8	21.2	67	nw.	10.7	1,280	650.2	16.8	46	6.5	wnw.	13.4	0
8.31 p. m.	709.8	21.2	67	nw.	9.4	892	680.4	17.9	64	9.7	wnw.	14.3	0
8.39 p. m.	709.8	21.0	69	nw.	10.3	526	709.8	21.0	69	12.5	nw.	10.3	......

August 21, 1912.—First flight: Six kites were used; lifting surface, 39.8 sq. m. Wire out, 4,300 m.; at maximum altitude, 4,100 m.

There were a few Ci.-St. from the west until 9.30 a. m.; thereafter A.-Cu. from the west and Cu. from the west-northwest increased from 1/10 to 10/10. The head kite was in Cu., altitude 1,650 m., from 11.04 to 11.07 a. m. and at 11.13 a. m.

Low pressure (754 mm.), central over southern Ontario, covered the eastern United States.

Second flight: Six kites were used; lifting surface, 38.3 sq. m. Wire out, 5,500 m.; at maximum altitude, 5,000 m.

St.-Cu., from the west-northwest, varied from 8/10 to 10/10.

Third flight: Seven kites were used; lifting surface, 46.6 sq. m. Wire out, 6,000 m.; at maximum altitude, 4,200 m.

There were 10/10 St.-Cu, from the west-northwest. Rain fell from 6.55 to 7.05 p. m.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind. Dir.	Wind. Vel.	Alt.	Pressure.	Temperature.	Humidity. Rel.	Humidity. Abs.	Wind. Dir.	Wind. Vel.	P. D. kite and earth.
Aug. 21, 1912: *Fourth flight*—	*mm.*	*C.*	%		*m.p.s.*	*m.*	*mm.*	*C.*	%	*g/cu.m.*		*m.p.s.*	*Volts.*
11.03 p. m.	710.2	20.9	71	nw.	7.2	526	710.2	20.9	71	12.8	nw.	7.2	......
11.11 p. m.	710.2	20.9	71	nw.	6.7	875	682.1	19.2	70	11.4	wnw.	14.3	0
Aug. 22, 1912:													
12.59 a. m.	710.1	20.4	76	wnw.	6.7	1,398	641.8	17.8	58	8.7	wnw.	6.6	0
1.26 a. m.	710.1	20.0	76	wnw.	6.3	1,690	620.1	15.1	58	7.4	wnw.	7.0	......
1.46 a. m.	710.1	20.0	77	wnw.	6.7	1,293	649.5	17.5	66	9.7	wnw.	6.2	......
2.04 a. m.	710.1	19.8	78	nw.	5.4	873	682.1	18.4	72	11.2	nw.	11.4	0
2.10 a. m.	710.1	19.8	78	wnw.	5.4	526	710.1	19.8	78	13.2	wnw.	5.4	......
Aug. 23, 1912: *First flight*—													
10.31 a. m.	709.8	20.2	69	nw.	12.1	526	709.8	20.2	69	11.9	nw.	12.1	......
10.42 a. m.	709.9	20.2	68	wnw.	10.3	965	674.7	17.1	67	9.7	wnw.	16.8	0
10.52 a. m.	709.9	20.6	53	wnw.	9.8	1,351	644.7	13.1	73	8.3	wnw.	18.8	0
11.08 a. m.	710.1	21.4	52	wnw.	13.4	2,142	586.5	7.1	70	5.4	wnw.	24.4	160
11.18 a. m.	710.2	21.8	55	wnw.	12.1	3,071	523.6	2.8	76	4.4	wnw.	24.4	480
11.39 a. m.	710.3	20.4	48	wnw.	11.6	3,180	516.5	2.4	70	4.0	w.	18.9	510
11.43 a. m.	710.4	20.4	48	wnw.	11.6	3,308	508.4	2.5	49	2.8	w.	23.5	620
11.58 a. m.	710.5	21.0	52	wnw.	11.6	3,818	477.4	−0.5	34	1.6	w.	24.5	......
11.59 a. m.	710.5	21.0	52	wnw.	11.6	3,827	476.3	0.2	33	1.6	w.	24.5	......
12.02 p. m.	710.5	21.0	52	wnw.	10.7	3,743	480.9	−0.5	28	1.3	w.	24.5	750
12.15 p. m.	710.6	21.1	51	wnw.	10.7	3,203	514.3	0.3	23	1.1	w.	21.4	540
12.31 p. m.	710.6	21.2	47	wnw.	11.6	2,806	540.3	2.8	54	3.2	w.	17.8	390
12.40 p. m.	710.6	21.5	46	wnw.	15.2	2,277	576.5	6.5	40	3.0	w.	19.1	260
12.45 p. m.	710.6	21.7	46	wnw.	15.2	1,963	598.9	7.0	37	2.9	w.	21.1	200
12.55 p. m.	710.7	21.8	46	wnw.	10.7	1,862	606.4	5.7	67	4.7	wnw.	18.4	170
1.05 p. m.	710.7	21.8	45	nw.	10.7	1,339	645.9	10.5	65	6.3	wnw.	14.8	0
1.19 p. m.	710.8	21.0	45	nw.	10.3	975	674.7	15.4	50	6.5	nw.	15.3	0
1.25 p. m.	710.9	21.6	46	nw.	12.1	526	710.9	21.6	46	8.6	wnw.	12.1	......
Second flight—													
1.58 p. m.	711.1	20.8	51	wnw.	11.6	526	711.1	20.8	51	9.1	nw.	11.6	......
2.12 p. m.	711.1	20.8	46	wnw.	10.3	957	676.4	17.9	48	7.3	wnw.	15.3	0
2.22 p. m.	711.1	21.0	48	wnw.	9.4	1,410	641.4	14.1	54	6.5	wnw.	15.8	0
2.35 p. m.	711.1	22.6	42	wnw.	10.7	1,989	598.4	7.3	67	5.3	wnw.	17.8	0
2.57 p. m.	711.1	22.2	42	wnw.	11.2	2,775	543.6	0.7	78	4.0	nw.	22.4	330
3.16 p. m.	711.3	22.2	42	wnw.	8.0	3,329	507.4	−1.9	56	2.3	wnw.	23.5	550
3.17 p. m.	711.3	22.2	42	wnw.	9.4	3,367	505.0	−1.6	53	2.3	wnw.	23.5	550
3.26 p. m.	711.4	22.1	42	wnw.	9.4	3,568	492.5	−3.6	50	1.8	wnw.	24.4	......
3.27 p. m.	711.5	22.1	43	wnw.	9.8	3,645	487.9	−3.4	47	1.7	wnw.	24.4	......
3.32 p. m.	711.5	22.0	44	wnw.	8.0	3,685	484.4	−3.2	37	1.4	wnw.	28.5	......
3.38 p. m.	711.6	22.0	46	wnw.	7.6	3,148	517.7	−2.4	51	2.0	wnw.	22.4	350
3.40 p. m.	711.6	22.0	46	wnw.	9.8	3,078	522.4	−2.7	61	2.4	wnw.	22.4	310
3.47 p. m.	711.7	22.2	46	wnw.	7.2	2,687	548.5	−0.9	81	3.6	wnw.	17.7	170
4.00 p. m.	711.9	22.1	46	wnw.	6.7	2,225	581.2	1.8	94	5.1	wnw.	20.4	10
4.10 p. m.	712.0	21.8	44	w.	7.6	1,872	607.1	5.9	76	5.5	wnw.	15.8	0
4.22 p. m.	712.0	21.2	47	w.	8.0	1,334	647.8	11.4	62	6.3	w.	15.3	0
4.33 p. m.	712.1	21.4	45	w.	8.0	953	677.7	16.6	50	7.0	w.	16.8	0
4.41 p. m.	712.1	21.2	46	wnw.	10.3	526	712.1	21.2	46	8.4	w.	10.3	......

August 22, 1912.—Fourth flight: Five kites were used; lifting surface, 35.0 sq. m. Wire out, 2,600 m.; at maximum altitude, 2,500 m.

St.-Cu., from the west-northwest, varied from 5/10 to 10/10. Light rain fell from 12.17 to 12.30 a. m.

August 23, 1912.—First flight: Five kites were used; lifting surface, 31.5 sq. m. Wire out, 5,500 m.; at maximum altitude, 5,350 m.

There were 8/10 Cu. and St.-Cu., from the west, before 11.30 a. m.; thereafter St.-Cu. varied from 2/10 to 9/10.

At 8 a. m. low pressure (748 mm.), central over the middle St. Lawrence, covered the United States except the Florida peninsula.

Second flight: Five kites were used; lifting surface, 31.5 sq. m. Wire out, 5,300 m.; at maximum altitude, 4,700 m.

St.-Cu., from the west-northwest, varied from 1/10 to 9/10. The head kite was in St.-Cu., at 3.39 and 3.47 p. m.; altitude of base, 2,600 m.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Alt.	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
Aug. 23, 1912:													
Third flight—	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%	*g/cu.m.*		*m. p. s.*	*Volts.*
5.13 p. m.	712.3	21.0	46	w.	8.0	526	712.3	21.0	46	8.3	w.	8.0	......
5.22 p. m.	712.4	20.9	47	wnw.	8.5	996	674.7	17.7	52	7.8	w.	16.6	0
5.33 p. m.	712.5	20.2	54	wnw.	6.7	1,470	638.2	13.7	63	7.4	w.	13.3	0
5.57 p. m.	712.8	19.5	59	wnw.	4.0	2.074	593.8	7.0	78	6.0	wnw.	18.7	20
6.12 p. m.	712.9	19.5	58	wnw.	4.5	2,778	544.7	1.8	78	4.3	wnw.	21.4	460
6.33 p. m.	713.0	18.9	61	wnw.	5.4	3,225	515.0	−1.9	79	3.3	wnw.	22.4	......
6.35 p. m.	713.0	18.8	62	wnw.	4.5	3,264	512.6	−1.5	64	2.7	wnw.	22.4	......
6.37 p. m.	713.0	18.6	63	wnw.	4.5	3.276	511.5	−2.0	54	2.2	wnw.	22.4	......
6.48 p. m.	713.1	19.2	62	wnw.	4.5	3.235	513.8	−1.0	62	2.8	wnw.	19.2	......
6.50 p. m.	713.1	19.3	62	wnw.	6.3	3.180	517.4	−1.4	65	2.8	wnw.	19.2	......
6.55 p. m.	713.2	19.6	61	wnw.	6.3	3,072	524.5	−0.3	59	2.8	wnw.	18.7	580
6.57 p. m.	713.2	19.7	61	wnw.	6.3	3,038	526.7	−0.8	68	3.1	wnw.	18.7	560
7.10 p. m.	713.4	19.4	59	wnw.	5.8	2,695	549.6	1.1	71	3.7	wnw.	26.4	320
7.25 p. m.	713.6	18.9	54	wnw.	5.8	2,226	582.6	4.5	64	4.2	wnw.	22.4	0
7.40 p. m.	713.9	19.0	54	wnw.	9.4	1,614	627.9	8.0	68	5.6	wnw.	18.9	0
7.53 p. m.	714.1	18.8	55	wnw.	6.3	1,078	669.4	14.3	62	7.6	wnw.	16.8	0
8.02 p. m.	714.2	18.2	59	wnw.	6.3	526	714.2	18.2	59	9.1	wnw.	6.3	......
Fourth flight—													
8.49 p. m.	714.4	18.8	57	w.	10.3	526	714.4	18.8	57	9.1	wnw.	10.3	......
9.05 p. m.	714.6	18.6	57	w.	10.3	1 998	676.3	16.2	63	8.6	wnw.	18.4	0
9.14 p. m.	714.7	18.6	57	w.	9.4	2,586	631.0	11.2	76	7.6	wnw.	20.4	0
9.30 p. m.	714.9	18.8	56	w.	8.9	2,329	577.2	5.1	78	5.3	wnw.	19.3	290
9.44 p. m.	715.1	18.6	57	w.	7.6	2,783	545.8	0.6	84	4.2	wnw.	17.8	420
9.57 p. m.	715.3	18.5	56	w.	6.7	2,801	544.6	1.3	85	4.5	wnw.	17.7	430
9.59 p. m.	715.3	18.5	56	w.	7.2	4,947	534.9	4.3	57	3.7	wnw.	17.7	610
10.17 p. m.	715.3	17.5	63	w.	7.6	3,052	465.9	−1.2	28	1.2	wnw.	23.3	730
10.40 p. m.	715.4	17.8	63	w.	5.8	2,055	526.8	3.2	22	1.3	w.	18.8	270
10.45 p. m.	715.4	18.2	60	w.	5.8	2,576	559.0	0.3	33	1.6	w.	17.3	40
10.52 p. m.	715.4	18.2	60	w.	7.2	1,198	585.8	4.1	77	4.9	w.	17.2	0
11.08 p. m.	715.4	18.0	63	w.	7.2	,537	634.8	8.5	76	6.4	w.	13.5	0
11.20 p. m.	715.5	18.2	60	w.	6.7	991	677.6	14.3	72	8.8	w.	15.3	0
11.26 p. m.	715.5	18.0	62	w.	7.2	526	715.5	18.0	62	9.4	w.	7.2	......
Fifth flight—													
12.03 a. m.	715.6	18.1	62	w.	7.6	526	715.6	18.1	62	9.5	w.	7.6	......
12.04 a. m.	715.6	18.1	62	w.	7.6	612	708.6	18.6	63	9.9	w.	13.6	0
12.19 a. m.	715.6	18.0	63	w.	7.2	1 923	683.3	15.9	68	9.1	w.	14.8	0
12.36 a. m.	715.6	18.0	62	w.	7.6	2,405	645.5	12.4	75	8.1	w.	17.8	0
12.52 a. m.	715.6	18.0	62	w.	7.6	2,121	592.4	7.0	67	5.2	wnw.	16.3	20
1.21 a. m.	715.7	17.8	62	w.	9.8	2,471	567.8	5.3	39	2.7	wnw.	11.7	430
1.38 a. m.	715.7	17.7	62	w.	8.5	3,898	538.9	7.4	29	2.3	wnw.	15.9	230
1.49 a. m.	715.8	17.4	65	w.	8.0	2,085	527.2	6.5	24	1.8	wnw.	15.4	170
2.15 a. m.	715.8	16.2	71	wnw.	8.0	2,439	570.2	10.0	21	2.0	wnw.	14.5	30
2.16 a. m.	715.8	16.1	71	wnw.	8.0	2,349	576.4	9.3	20	1.8	wnw.	14.5	10
2.23 a. m.	715.8	16.1	71	wnw.	8.0	1,121	592.4	10.0	19	1.8	wnw.	17.1	0
2.27 a. m.	715.8	15.9	72	wnw.	8.9	1,947	604.8	9.1	21	1.9	wnw.	18.6	0
2.36 a. m.	715.9	15.6	73	wnw.	8.9	,489	639.1	10.7	51	5.0	wnw.	23.5	0
2.51 a. m.	715.9	15.4	73	wnw.	8.9	956	680.7	14.8	69	8.7	wnw.	19.9	0
3.01 a. m.	715.9	15.7	72	wnw.	7.6	614	708.6	17.2	67	9.7	wnw.	....	0
3.05 a. m.	715.9	15.9	71	wnw.	7.6	526	715.9	15.9	71	9.5	wnw.	7.6	......

August 23, 1912.—Third flight: Five kites were used; lifting surface, 31.5 sq. m. Wire out, 5,500 m.; at maximum altitude.

6/10 St.-Cu., from the west-northwest, disappeared before 6 p. m.

Fourth flight: Five kites were used; lifting surface, 31.5 sq. m. Wire out, 5,500 m.; at maximum altitude, 4,900 m.

Between 9.50 and 10.50 p. m. there were from a few to 2/10 St.-Cu. from the west-northwest.

Fifth flight: Five kites were used; lifting surface, 33.5 sq. m. Wire out, 5,500 m.; at maximum altitude, 4,300 m.

The sky was cloudless.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Alt.	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
Aug. 23, 1912:													
Sixth flight—	*mm.*	*C.*	*%*		*m. p. s.*	*m.*	*mm.*	*C.*	*%*	*g/cu. m.*		*m. p. s.*	*Volts.*
3.40 a. m.	716.2	15.6	74	wnw.	6.7	526	716.2	15.6	74	9.8	wnw.	6.7	......
3.41 a. m.	716.2	15.6	74	wnw.	6.7	575	712.1	17.3	73	10.7	wnw.	......	0
3.47 a. m.	716.2	15.6	74	wnw.	8.9	952	681.4	15.2	73	9.4	wnw.	18.4	0
4.09 a. m.	716.4	15.6	74	wnw.	8.0	1,811	615.5	10.3	73	6.9	wnw.	17.8	0
4.15 a. m.	716.4	15.8	74	wnw.	8.9	2,156	590.7	12.3	39	4.2	wnw.	18.5	10
4.33 a. m.	716.6	16.0	72	wnw.	7.2	2,952	537.2	8.8	29	2.5	wnw.	20.2	600
5.00 a. m.	716.8	16.4	68	wnw.	8.0	3,678	492.0	4.0	24	1.5	wnw.	17.8	950
5.15 a. m.	717.1	16.6	69	wnw.	8.0	3,977	473.8	1.5	32	1.7	w.	20.1	......
5.30 a. m.	717.4	16.8	68	wnw.	7.6	3,553	498.8	3.9	37	2.3	w.	17.6	810
5.41 a. m.	717.6	16.6	68	w.	7.2	2,894	540.8	6.2	31	2.3	w.	15.6	610
5.55 a. m.	717.8	16.4	70	w.	7.6	2,216	586.9	11.2	29	2.9	wnw.	13.8	430
6.03 a. m.	717.9	16.3	71	w.	4.0	2,007	601.8	10.5	26	2.5	wnw.	16.3	300
6.05 a. m.	717.9	16.3	71	w.	4.0	1,870	611.8	10.6	25	2.4	wnw.	16.1	220
6.07 a. m.	717.9	16.3	71	w.	4.0	1,682	625.7	8.8	42	3.6	wnw.	21.8	100
6.19 a. m.	718.0	16.4	71	wsw.	3.6	1,234	660.4	11.1	80	8.0	wnw.	14.6	0
6.27 a. m.	718.1	16.6	71	wsw.	3.6	743	700.0	15.5	71	9.3	wnw.	7.2	0
6.29 a. m.	718.1	16.8	71	wsw.	3.6	526	718.1	16.8	71	10.0	wsw.	3.6	......
Seventh flight—													
9.28 a. m.	719.0	21.0	63	s.	3.6	526	719.0	21.0	63	11.4	s.	3.6	......
9.34 a. m.	718.9	21.2	62	sw.	3.1	2,150	593.9	11.2	......	......	wnw.	......	......
9.50 a. m.	718.9	22.0	60	sw.	3.1	1,458	645.0	13.8	......	......	wsw.	......	......
10.05 a. m.	718.9	22.5	56	ssw.	3.1	1,057	676.1	17.4	......	......	sw.	......	......
10.25 a. m.	718.9	21.8	59	ssw.	2.7	526	718.9	21.8	59	11.2	ssw.	2.7	......
Eighth flight—													
10.39 a. m.	718.9	22.0	58	sw.	4.0	526	718.9	22.0	58	11.1	sw.	4.0	......
10.47 a. m.	718.9	22.2	56	ssw.	2.7	1,953	608.2	11.4	......	......	w.	......	......
10.58 a. m.	718.9	22.4	58	sw.	2.7	1,584	635.5	12.9	......	......	w.	......	......
11.21 a. m.	718.9	22.6	56	sw.	3.6	1,034	678.0	18.4	......	......	sw.	......	......
11.34 a. m.	718.8	22.8	56	wsw.	4.5	751	700.5	20.2	......	......	sw.	......	......
11.43 a. m.	718.8	22.8	57	wsw.	3.6	526	718.8	22.8	57	11.5	wsw.	3.6	......
Ninth flight—													
11.54 a. m.	718.8	22.8	55	ssw.	5.4	526	718.8	22.8	55	11.1	ssw.	5.4	......
12.03 p. m.	718.8	23.2	54	ssw.	4.0	2,133	595.7	11.7	......	......	ssw.	......	......
12.30 p. m.	718.7	24.0	53	ssw.	3.6	1,586	635.5	15.4	......	......	sw.	......	......
12.35 p. m.	718.7	24.0	53	sse.	4.5	1,155	668.5	17.3	......	......	ssw.	......	......
1.03 p. m.	718.6	24.0	55	sse.	5.4	526	718.6	24.0	55	11.8	sse.	5.4	......

August 23, 1912.—*Sixth flight:* Five kites were used; lifting surface, 33.5 sq. m.; Wire out, 5,500 m.; at maximum altitude, 5,000 m.

The sky was cloudless.

Seventh flight: One captive balloon was used; capacity, 28.7 cu. m. Wire out, 2,500 m.

There were a few Cu., from the west-southwest, after 9.40 a. m.

At 8 a. m., high pressure (765 mm.) was central over western North Carolina. Low pressure (752 mm.) was central over Nova Scotia.

Eighth flight: One captive balloon was used; capacity, 28.7 cu. m. Wire out, 2,530 m.

Cu., from the west-southwest, increased from a few to 1/10. The balloon was in Cu. at 10.43 a. m.; altitude, 1,750 m.

Ninth flight: One captive balloon was used; capacity, 28.7 cu. m. Wire out, 2,500 m. Cu., from the west-southwest, decreased from 1/10 to a few.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Alt.	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
Aug. 29, 1912:													
First flight—	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%	*g/cu.m.*		*m. p. s.*	*Volts.*
1.34 p. m...	713.2	20.0	86	nw.	6.3	526	713.2	20.0	86	14.7	nw.	6.3	......
1.37 p. m...	713.2	19.9	87	nw.	5.8	569	709.6	19.4	96	15.9	nnw.	6.1	0
2.00 p. m...	713.2	19.4	91	nw.	5.4	717	697.6	18.4	93	14.5	nnw.	9.2	0
2.04 p. m...	713.2	19.2	93	nw.	5.4	900	682.9	19.1	93	15.1	nnw.	13.3	0
2.18 p. m...	713.2	19.2	88	nnw.	6.3	1,354	647.7	17.4	92	13.5	nw.	16.8	0
2.36 p. m...	713.3	19.0	89	nnw.	8.0	1,926	605.7	14.2	83	10.0	nw.	18.4	170
2.53 p. m...	713.3	18.5	88	nnw.	7.6	2,671	554.1	7.5	99	7.9	nw.	18.4	640
3.00 p. m...	713.3	18.3	89	nnw.	8.5	2,811	544.6	6.7	83	6.3	nw.	17.3	710
3.04 p. m...	713.3	18.2	90	nnw.	7.6	3,031	530.3	7.8	66	5.4	nw.	20.4	820
3.15 p. m...	713.4	18.2	90	nnw.	7.2	3,331	511.5	6.4	46	3.4	nw.	19.3	950
3.21 p. m...	713.5	18.1	90	nnw.	8.9	3,443	504.7	6.7	38	2.9	nw.	18.4	1,170
3.28 p. m...	713.5	18.0	92	nnw.	7.6	4,015	470.5	4.1	28	1.8	nw.	20.4	1,140
3.34 p. m...	713.6	18.0	92	nnw.	7.6	4,165	461.6	2.3	25	1.4	nw.	23.1	......
3.51 p. m...	713.7	17.8	90	nw.	9.4	3,619	493.0	6.0	20	1.4	nw.	21.4	980
4.02 p. m...	713.8	17.7	91	nnw.	7.2	2,875	539.7	7.8	40	3.2	nw.	20.4	680
4.04 p. m...	713.8	17.7	91	nnw.	6.7	2,764	547.0	6.5	60	4.5	nw.	19.4	680
4.08 p. m...	713.8	17.7	91	nnw.	7.6	2,692	551.7	7.6	83	6.6	nw.	22.4	680
4.10 p. m...	713.8	17.7	90	nnw.	7.6	2,578	559.4	7.4	88	7.0	nw.	19.7	625
4.19 p. m...	713.8	17.5	88	nw.	7.6	2,020	598.2	10.6	90	8.7	nw.	18.9	425
4.36 p. m...	713.9	17.8	88	nw.	7.6	1,369	646.4	15.4	92	12.0	nw.	18.4	170
4.38 p. m...	713.9	17.7	88	nw.	7.6	1,268	654.1	14.8	94	11.8	nw.	19.1	120
4.46 p. m...	713.9	17.6	88	nw.	6.7	903	682.9	14.8	81	10.2	nnw.	17.8	0
4.48 p. m...	713.9	17.6	88	nw.	6.3	674	701.6	14.9	86	10.9	nnw.	16.1	0
4.51 p. m...	713.9	17.7	87	nnw.	6.3	526	713.9	17.7	87	13.0	nnw.	6.3	......
Second flight—													
5.19 p. m...	714.0	17.4	87	nnw.	7.2	526	714.0	17.4	87	12.8	nnw.	7.2	......
5.34 p. m...	714.1	17.2	88	nw.	5.8	923	681.7	16.2	79	10.8	nnw.	15.8	50
5.48 p. m...	714.1	17.2	88	nw.	4.9	1,373	646.5	14.0	98	11.7	nw.	15.5	170
5.52 p. m...	714.2	17.2	88	nw.	5.4	1,391	645.2	15.8	92	12.3	nw.	18.9	170
6.00 p. m...	714.2	17.0	90	nw.	5.4	1,821	613.4	14.4	80	9.8	nw.	19.9	650
6.09 p. m...	714.2	17.0	90	nw.	4.5	2,545	562.8	10.7	79	7.7	nw.	21.9	900
6.23 p. m...	714.2	16.8	90	nw.	4.5	3,315	512.9	5.8	62	4.4	nw.	18.9	980
6.36 p. m...	714.2	16.6	90	nw.	5.4	3,616	494.4	4.8	50	3.3	nw.	19.4	1,150
6.37 p. m...	714.2	16.6	90	nw.	5.4	3,687	490.0	5.8	37	2.6	nw.	22.0	1,205
6.52 p. m...	714.2	16.6	90	nw.	5.8	4,027	469.6	2.6	27	1.6	nw.	21.4	1,240
7.05 p. m...	714.2	16.4	90	nw.	6.3	3,755	485.4	4.6	24	1.6	nw.	21.3	900
7.15 p. m...	714.3	16.4	90	nw.	5.8	3,452	503.7	6.6	22	1.7	nw.	23.1	800
7.19 p. m...	714.3	16.4	90	nw.	6.3	3,265	515.3	5.0	24	1.6	nw.	21.0	650
7.35 p. m...	714.4	16.4	91	wnw.	6.7	2,539	562.8	8.4	74	6.2	nw.	16.7	515
7.49 p. m...	714.4	16.4	89	wnw.	7.2	1,874	609.6	11.9	81	8.5	nw.	23.5	380
8.00 p. m...	714.5	16.4	89	wnw.	7.2	1,394	645.2	15.6	77	10.2	nw.	23.5	170
8.05 p. m...	714.5	16.4	89	wnw.	6.3	1,126	665.9	14.8	88	11.1	nnw.	20.4	80
8.12 p. m...	714.6	16.4	89	wnw.	6.7	962	679.0	15.4	83	10.8	nnw.	15.8	0
8.18 p. m...	714.7	16.6	88	wnw.	6.7	526	714.7	16.6	88	12.3	wnw.	6.7	......

August 29, 1912.—First flight: Five kites were used; lifting surface, 39.8 sq. m. Wire out, 5,500 m.; at maximum altitude, 5,000 m.

There were 6/10 to 10/10 St.-Cu., from the north-northwest. At 2.15 p. m., St.-Cu., from the west-northwest, were seen through rifts in the lower St.-Cu. The head kite was in St.-Cu. at 1.57 p. m., altitude, 700 m.

At 8 a. m. high pressure (766 mm.) was central over the upper Lakes, low pressure (752 mm.) over the Gulf of St. Lawrence.

Second flight: Six kites were used; lifting surface, 39.8 sq. m. Wire out, 5,500 m.; at maximum altitude, 5,200 m.

There were two layers of St.-Cu. The upper, from the northwest, varied from 4/10 to 7/10 between 5.40 and 6.50 p. m., and disappeared by 7 p. m. The lower, from the north-northwest, decreased from 5/10 to none by 6 p. m.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Alt.	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
Aug. 29, 1912:													
Third flight—	*mm.*	*C.*	%		*m. p. s.*	*m.*	*mm.*	*C.*	%	*g/cu. m.*		*m. p. s.*	*Volts.*
8.46 p. m.	715.0	16.6	88	nw.	6.3	526	715.0	16.6	88	12.3	nw.	6.3	......
8.50 p. m.	715.0	16.6	88	nw.	6.3	594	709.4	17.0	85	12.2	nnw.	10.6	0
8.58 p. m.	715.1	16.4	90	nw.	5.8	1,889	685.4	15.5	85	11.1	nnw.	11.2	0
9.11 p. m.	715.1	16.3	90	nw.	4.9	1,317	651.5	12.4	93	10.1	nw.	11.2	0
9.26 p. m.	715.2	16.2	90	wnw.	5.8	1,515	636.6	14.0	86	10.3	nw.	17.3	330
9.31 p. m.	715.2	16.2	90	wnw.	5.8	1,900	608.2	13.5	79	9.2	nw.	14.3	380
10.00 p. m.	715.3	16.0	92	wnw.	5.4	2,352	576.5	11.7	58	6.0	nw.	11.2	490
11.22 p. m.	715.7	15.8	94	wnw.	6.7	2,614	559.0	10.7	42	4.1	nw.	10.5	425
11.30 p. m.	715.7	15.9	92	wnw.	7.2	2,756	549.5	9.4	40	3.6	nw.	12.8	......
11.40 p. m.	715.8	15.6	94	wnw.	5.4	2,541	563.9	11.0	43	4.3	nw.	11.2	350
11.50 p. m.	715.8	15.4	94	wnw.	4.9	1,818	614.5	14.2	40	4.8	nw.	10.2	170
11.54 p. m.	715.8	15.4	94	wnw.	5.4	1,730	620.8	14.9	39	4.9	nw.	10.0	120
11.57 p. m.	715.8	15.4	94	wnw.	5.4	1,492	638.6	12.0	42	4.4	nw.	11.7	100
Aug. 30, 1912:													
12.03 a. m.	715.8	15.4	94	wnw.	4.9	895	685.4	14.0	90	10.8	nw.	10.7	0
12.14 a. m.	715.9	15.1	95	nw.	4.9	526	715.9	15.1	95	12.1	nw.	4.9	......
Sept. 6, 1912:													
8.18 a. m.	717.5	22.2	86	wnw.	13.0	526	717.5	22.2	86	16.7	wnw.	13.0	......
8.32 a. m.	717.5	22.6	83	nw.	13.0	998	679.8	22.5	72	14.2	nw.	20.4	0
8.42 a. m.	717.5	22.8	82	wnw.	11.6	1,305	656.3	22.0	60	11.5	nw.	12.8	0
9.00 a. m.	717.4	23.3	82	wnw.	11.6	1,720	625.6	20.7	55	9.8	nw.	10.9	0
9.13 a. m.	717.4	23.6	82	wnw.	10.3	2,004	605.4	17.2	66	9.6	nw.	7.7	0
10.08 a. m.	717.2	25.1	79	wnw.	8.0	2,531	568.4	12.2	64	6.8	nw.	7.6	0
10.31 a. m.	717.0	25.5	73	wnw.	8.9	1,709	625.6	17.4	56	8.2	nw.	8.2	0
10.39 a. m.	717.0	25.8	72	wnw.	8.9	1,295	656.3	19.4	63	10.4	nw.	10.2	0
10.49 a. m.	716.9	26.0	71	nw.	9.8	1,124	669.4	20.6	64	11.3	nw.	10.8	0
10.50 a. m.	716.9	26.0	71	nw.	9.8	1,058	674.6	19.6	68	11.4	nw.	10.8	0
10.58 a. m.	716.8	26.0	72	nw.	7.6	856	690.4	20.7	80	14.3	nw.	12.8	0
11.06 a. m.	716.8	26.2	68	wnw.	8.9	526	716.8	26.2	68	16.6	wnw.	8.9	......
Sept. 16, 1912:													
First flight—													
8.25 a. m.	715.2	19.1	86	nw.	8.9	526	715.2	19.1	86	14.0	nw.	8.9	......
8.37 a. m.	715.3	19.0	86	wnw.	8.5	950	680.7	14.6	86	10.7	nnw.	17.8	0
8.44 a. m.	715.4	19.0	86	wnw.	8.5	1,216	659.7	11.8	91	9.5	nnw.	20.1	0
9.04 a. m.	715.5	19.0	85	wnw.	12.5	1,483	639.1	9.7	90	8.2	nnw.	16.8	0
9.14 a. m.	715.6	18.9	80	nw.	9.4	2,008	599.8	4.8	100	6.7	nnw.	18.4	0
9.19 a. m.	715.7	18.8	81	nw.	9.8	2,025	598.6	8.8	58	5.0	nnw.	17.8	0
9.24 a. m.	715.7	18.7	82	nw.	9.4	2,009	599.8	5.0	94	6.4	nnw.	20.0	0
9.37 a. m.	715.8	18.8	83	nw.	12.5	2,533	563.0	......	40	....	nnw.	15.8	170
9.50 a. m.	715.9	19.1	81	wnw.	8.9	2,919	537.7	......	36	....	nnw.	11.5	210
10.17 a. m.	716.0	20.0	76	wnw.	11.6	3,425	505.1	......	29	....	nnw.	19.7	......
10.27 a. m.	716.0	20.1	74	wnw.	11.2	2,955	535.3	......	32	....	nnw.	20.4	......
10.44 a. m.	715.9	20.3	72	wnw.	9.8	2,431	571.5	......	19	....	nnw.	16.3	0
10.57 a. m.	715.9	20.1	69	wnw.	8.0	1,437	642.9	10.6	73	7.1	nnw.	12.8	0
11.07 a. m.	715.9	20.4	69	wnw.	7.6	761	696.6	15.1	80	10.2	nnw.	12.2	0
11.14 a. m.	715.9	20.1	66	wnw.	8.9	526	715.9	20.1	66	11.4	wnw.	8.9	......

August 29, 1912.—Third flight: Seven kites were used; lifting surface, 47.1 sq. m. Wire out, 5,500 m.; at maximum altitude, 3,800 m.

St.-Cu., from the northwest, appeared about 10 p. m., increased to 9/10, and disappeared by 11.30 p. m.

September 6, 1912.—Seven kites were used; lifting surface, 44.1 sq. m. Wire out, 6,500 m.; at maximum altitude, 4,700 m.

St.-Cu., from the northwest, increased from a few to 4/10.

High pressure (765 mm.) was central over West Virginia. Low pressure (756 mm.) was central over Nova Scotia.

September 16, 1912.—First flight: Five kites were used; lifting surface, 31.5 sq. m. Wire out, 5,500 m.; at maximum altitude, 4,800 m.

The sky was covered with St.-Cu., from the north-northwest, until 10 a. m.; thereafter Ci.-St., from the west, and A.-Cu. and St.-Cu., from the north-northwest, decreased from 9/10 to 6/10. The head kite was in St.-Cu. at 8.55 a. m., altitude, 1,250 m.; and at 9.09 a. m., altitude, 1,850 m.

Low pressure (754 mm.) was central over Nantucket. High pressure (769 mm.) was central over the upper Lakes.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Alt.	Pressure.	Temperature.	Humidity.		Wind.		P.D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
Sept. 16, 1912:													
Second flight—	*mm.*	*C.*	%		*m.p.s.*	*m.*	*mm.*	*C.*	%	*g/cu.m.*		*m.p.s.*	*Volts.*
11.53 a.m.	715.7	20.6	66	nnw.	6.7	526	715.7	20.6	66	11.7	nnw.	6.7	......
12.02 p.m.	715.7	21.6	58	nw.	10.7	926	683.4	17.4	64	9.4	nnw.	....	0
12.14 p.m.	715.6	21.6	57	nw.	10.3	1,275	655.9	14.4	70	8.6	nnw.	....	0
12.24 p.m.	715.6	21.8	55	wnw.	10.3	1,628	629.0	11.6	73	7.5	nnw.	....	0
12.33 p.m.	715.5	21.5	57	nw.	9.8	1,868	611.3	14.8	46	5.8	nnw.	....	0
12.57 p.m.	715.4	21.8	53	nw.	8.9	2,504	566.9	13.3	18	2.1	nnw.	....	0
1.20 p.m.	715.3	21.5	58	wnw.	8.9	2,869	542.8	11.5	13	1.3	nw.	....	0
1.56 p.m.	715.1	22.0	58	wnw.	8.5	3,292	515.8	9.4	10	0.9	nw.	....	0
2.02 p.m.	715.1	21.5	57	nw.	8.5	3,436	506.6	8.0	13	1.1	nw.	....	0
2.15 p.m.	715.1	21.6	56	nw.	8.5	3,110	526.3	8.5	13	1.1	wnw	....	0
2.28 p.m.	715.1	20.9	60	nnw.	8.5	2,743	550.1	10.8	12	1.2	nw.	....	0
2.35 p.m.	715.1	21.6	56	nnw.	8.5	2,276	581.6	13.4	12	1.4	nnw.	....	0
2.40 p.m.	715.1	21.6	.56	nnw.	8.5	2,062	596.4	13.2	11	1.3	nnw.	....	0
2.41 p.m.	715.1	21.6	56	nnw.	8.5	1,993	601.3	9.2	11	1.0	nnw.	....	0
2.52 p.m.	715.1	21.9	58	n.	8.5	1,283	654.6	13.1	68	7.7	n.	....	0
3.02 p.m.	715.1	21.5	60	w.	8.5	885	686.0	16.5	67	9.3	n.	....	0
3.07 p.m.	715.1	21.2	58	nw.	8.5	526	715.1	21.2	58	10.6	nw.	8.5	......
Third flight—													
3.47 p.m.	715.2	21.4	58	n.	4.9	526	715.2	21.4	58	10.8	n.	4.9	......
3.56 p.m.	715.2	20.8	61	n.	4.9	758	696.3	18.6	56	8.8	n.	8.7	0
4.14 p.m.	715.2	20.6	60	n.	3.6	891	685.6	17.5	59	8.7	n.	9.7	0
4.30 p.m.	715.2	20.4	61	nnw.	3.6	1,024	675.0	16.5	62	8.6	nnw.	8.2	0
4.48 p.m.	715.3	20.4	62	nnw.	4.5	1,159	664.6	15.5	64	8.4	nnw.	10.4	......
4.55 p.m.	715.3	20.1	62	nw.	4.0	726	699.0	18.9	59	9.5	nnw.	8.4	0
4.58 p.m.	715.3	20.0	63	nw.	4.0	526	715.3	20.0	63	10.8	nw.	4.0	......
Sept. 27, 1912:													
First flight—													
8.43 a.m.	719.9	9.1	90	nw.	17.0	526	719.9	9.1	90	7.9	nw.	17.0	......
8.55 a.m.	719.9	9.2	90	nw.	16.1	921	686.4	8.8	80	6.9	nnw.	22.1	0
9.01 a.m.	719.9	9.4	88	wnw.	16.1	953	683.8	14.2	48	5.8	nw.	10.7	0
9.10 a.m.	719.9	9.4	90	wnw.	16.1	953	683.8	15.8	41	5.5	nw.	10.9	0
9.27 a.m.	719.9	9.6	88	wnw.	14.8	1,415	647.5	11.5	36	3.7	nw.	7.6	0
9.45 a.m.	719.9	10.2	86	wnw.	13.9	1,781	619.5	8.6	31	2.6	nw.	9.2	0
10.20 a.m.	719.9	10.6	82	wnw.	15.6	1,610	632.2	9.4	27	2.4	nw.	8.7	0
10.54 a.m.	719.9	10.8	82	nw.	13.4	1,213	662.9	13.9	20	2.4	nnw.	7.5	0
10.56 a.m.	719.9	10.8	82	nw.	13.4	1,017	678.6	7.5	26	2.1	nnw.	16.8	0
11.02 a.m.	719.9	10.9	82	nw.	14.8	922	686.4	7.8	85	6.9	nnw.	16.1	0
11.06 a.m.	719.9	11.0	82	wnw.	11.2	526	719.9	11.0	82	8.1	wnw.	11.2	......

September 16, 1912.—Second flight: Seven kites were used; lifting surface, 46.1 sq. m. Wire out, 6,200 m.; at maximum altitude, 5,300 m.

Ci.-St., from the west, and St.-Cu., from the north-northwest, increased from 7/10 to 10/10. The head kite was in St.-Cu. at 12.27 p. m., altitude 1,750 m., and at 1.10 p. m., altitude 2,500 m.

Third flight: Two kites were used; lifting surface, 15.1 sq. m. Wire out, 960 m.; at maximum altitude, 900 m.

The sky was covered with A.-St., from the west, and St.-Cu., from the north-northwest.

September 27, 1912.—First flight: Six kites were used; lifting surface, 37.8 sq. m. Wire out, 5,700 m.; at maximum altitude, 4,400 m.

The sky was covered with St.-Cu., from the west.

High pressure (772 mm.), central over South Dakota, covered the United States.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Alt.	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
Sept. 27, 1912: *Second flight*	*mm.*	*C.*	*%*		*m. p. s.*	*m.*	*mm.*	*C.*	*%*	*g/cu.m.*		*m. p. s.*	*Volts.*
11.49 a. m.	719.9	12.0	76	nw.	11.6	526	719.9	12.0	76	8.0	nw.	11.6	......
11.58 a. m.	719.9	12.4	74	wnw.	14.3	824	694.7	9.6	78	7.1	nw.	17.8	0
12.02 p. m.	719.9	12.6	74	nw.	14.3	1,065	674.9	9.4	52	4.7	nw.	15.3	0
12.03 p. m.	719.9	12.6	74	nw.	14.3	1,164	667.0	13.2	44	5.0	nw.	15.3	0
12.19 p. m.	719.9	12.8	77	nw.	15.2	1,263	659.2	14.1	22	2.6	nw.	6.1	0
12.29 p. m.	719.9	13.4	70	nw.	12.5	1,533	638.6	12.1	20	2.1	nw.	8.0	0
12.31 p. m.	720.0	13.5	71	wnw	11.2	1,632	631.0	9.5	19	1.7	nw.	9.5	0
12.33 p. m.	720.0	13.6	72	wnw	11.6	1,683	627.2	10.2	18	1.7	nw.	7.1	0
12.37 p. m.	720.0	13.8	68	wnw.	11.2	1,837	615.8	9.6	18	1.6	nw.	6.6	0
1.45 p. m.	720.1	15.0	60	wnw.	8.5	1,974	605.8	9.3	16	1.4	nw.	5.3	0
1.55 p. m.	720.1	14.8	60	nw.	8.0	2,214	588.4	8.4	16	1.3	nw.	7.6	0
2.06 p. m.	720.1	15.2	59	nnw.	8.5	1,665	628.5	10.6	16	1.6	nw.	7.8	0
2.10 p. m.	720.1	15.1	60	wnw.	8.5	1,497	641.2	9.7	16	1.5	nnw.	16.4	0
2.14 p. m.	720.2	14.9	60	wnw.	8.0	1,364	651.5	10.4	15	1.4	nw.	14.6	0
2.16 p. m.	720.2	14.8	59	wnw.	7.2	1,169	667.0	8.6	30	2.6	nnw.	11.0	0
2.26 p. m.	720.2	14.6	56	wnw.	8.5	782	698.6	11.5	61	6.3	nw.	9.7	0
2.32 p. m.	720.3	14.9	57	nw.	6.7	526	720.3	14.9	57	7.2	nw.	6.7	......

September 27, 1912.—Second flight: Seven kites were used; lifting surface, 46.1 sq. m. Wire out, 5,800 m.: at maximum altitude, 2,400 m.

Ci.-Cu., A.-Cu., and St.-Cu., from the west, varied from 7/10 to 3/10.

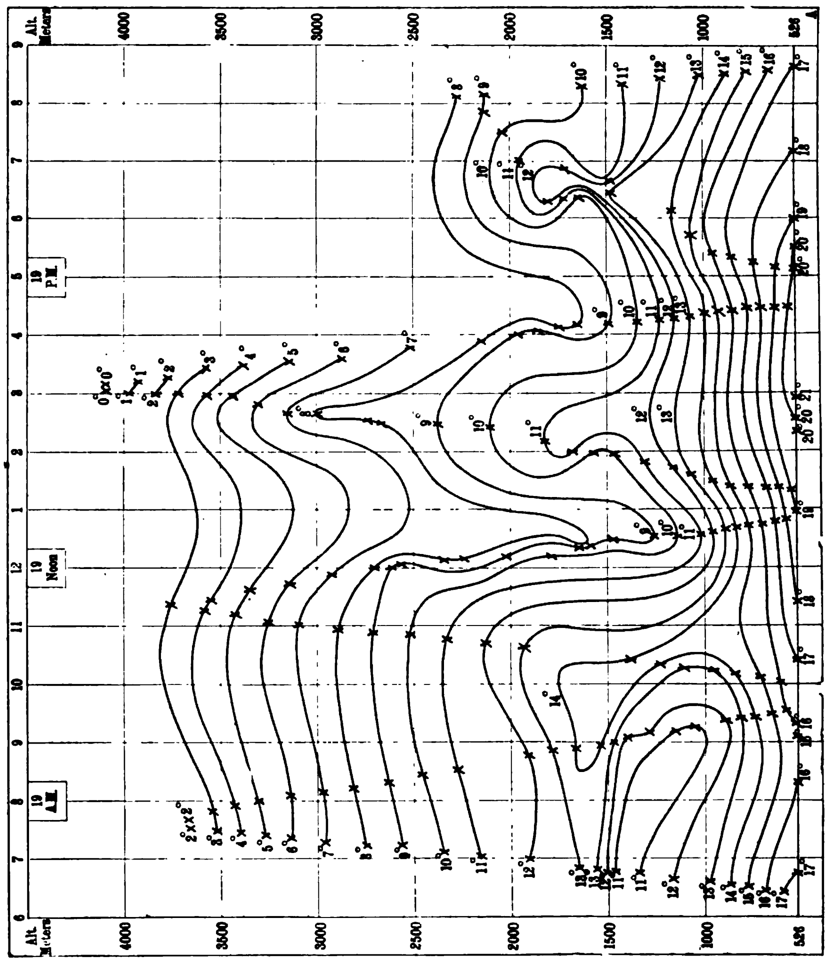


FIG. 1.—Free air isotherms above Mount Weather, observed July 19, 1912.

Results of free air observations—Continued.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Alt.	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
Sept. 27, 1912: *Second flight* –	*mm.*	*C.*	*%*		*m. p. s.*	*m.*	*mm.*	*C.*	*%*	*g/cu. m.*		*m. p. s.*	*Volts.*
11.49 a. m. .	719.9	12.0	76	nw.	11.6	526	719.9	12.0	76	8.0	nw.	11.6	......
11.58 a. m. .	719.9	12.4	74	wnw.	14.3	824	694.7	9.6	78	7.1	nw.	17.8	0
12.02 p. m. .	719.9	12.6	74	nw.	14.3	1,065	674.9	9.4	52	4.7	nw.	15.3	0
12.03 p. m. .	719.9	12.6	74	nw.	14.3	1,164	667.0	13.2	44	5.0	nw.	15.3	0
12.19 p. m. .	719.9	12.8	77	nw.	15.2	1,263	659.2	14.1	22	2.6	nw.	6.1	0
12.29 p. m. .	719.9	13.4	70	nw.	12.5	1,533	638.6	12.1	20	2.1	nw.	8.0	0
12.31 p. m. .	720.0	13.5	71	wnw	11.2	1,632	631.0	9.5	19	1.7	nw.	9.5	0
12.33 p. m. .	720.0	13.6	72	wnw	11.6	1,683	627.2	10.2	18	1.7	nw.	7.1	0
12.37 p. m. .	720.0	13.8	68	wnw.	11.2	1,837	615.8	9.6	18	1.6	nw.	6.6	0
1.45 p. m. . .	720.1	15.0	60	wnw.	8.5	1,974	605.8	9.3	16	1.4	nw.	5.3	0
1.55 p. m. . .	720.1	14.8	60	nw.	8.0	2,214	588.4	8.4	16	1.3	nw.	7.6	0
2.06 p. m. . .	720.1	15.2	59	nnw.	8.5	1,665	628.5	10.6	16	1.6	nw.	7.8	0
2.10 p. m. . .	720.1	15.1	60	wnw.	8.5	1,497	641.2	9.7	16	1.5	nnw.	16.4	0
2.14 p. m. . .	720.2	14.9	60	wnw.	8.0	1,364	651.5	10.4	15	1.4	nw.	14.6	0
2.16 p. m. . .	720.2	14.8	59	wnw.	7.2	1,169	667.0	8.6	30	2.6	nnw.	11.0	0
2.26 p. m. . .	720.2	14.6	56	wnw.	8.5	782	698.6	11.5	61	6.3	nw.	9.7	0
2.32 p. m. . .	720.3	14.9	57	nw.	6.7	526	720.3	14.9	57	7.2	nw.	6.7	......

September 27, 1912.—Second flight: Seven kites were used; lifting surface, 46.1 sq. m. Wire out, 5,800 m.: at maximum altitude, 2,400 m.

Ci.-Cu., A.-Cu., and St.-Cu., from the west, varied from 7/10 to 3/10.

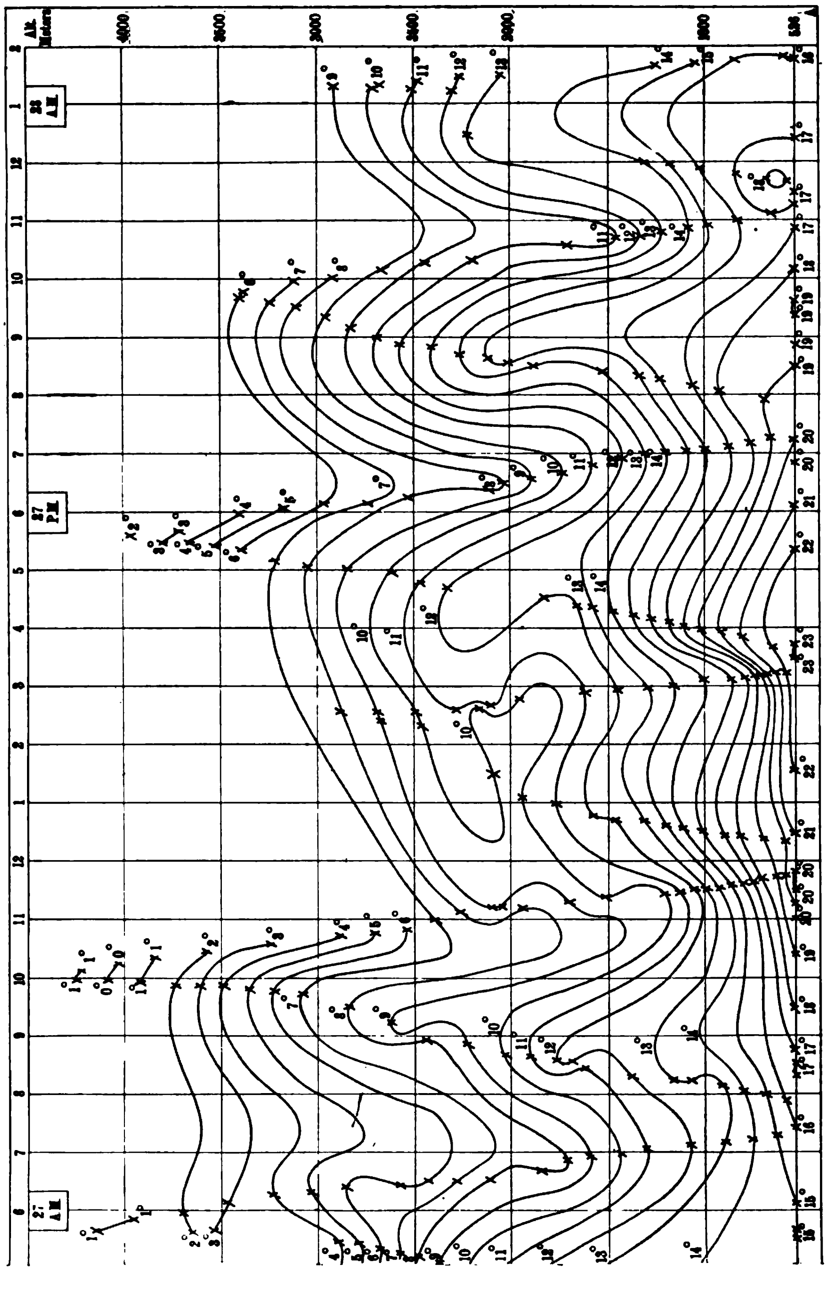


Fig. 26.—Free air isotherms above Mount Weather; observed July 26, 27, 28, 1912.

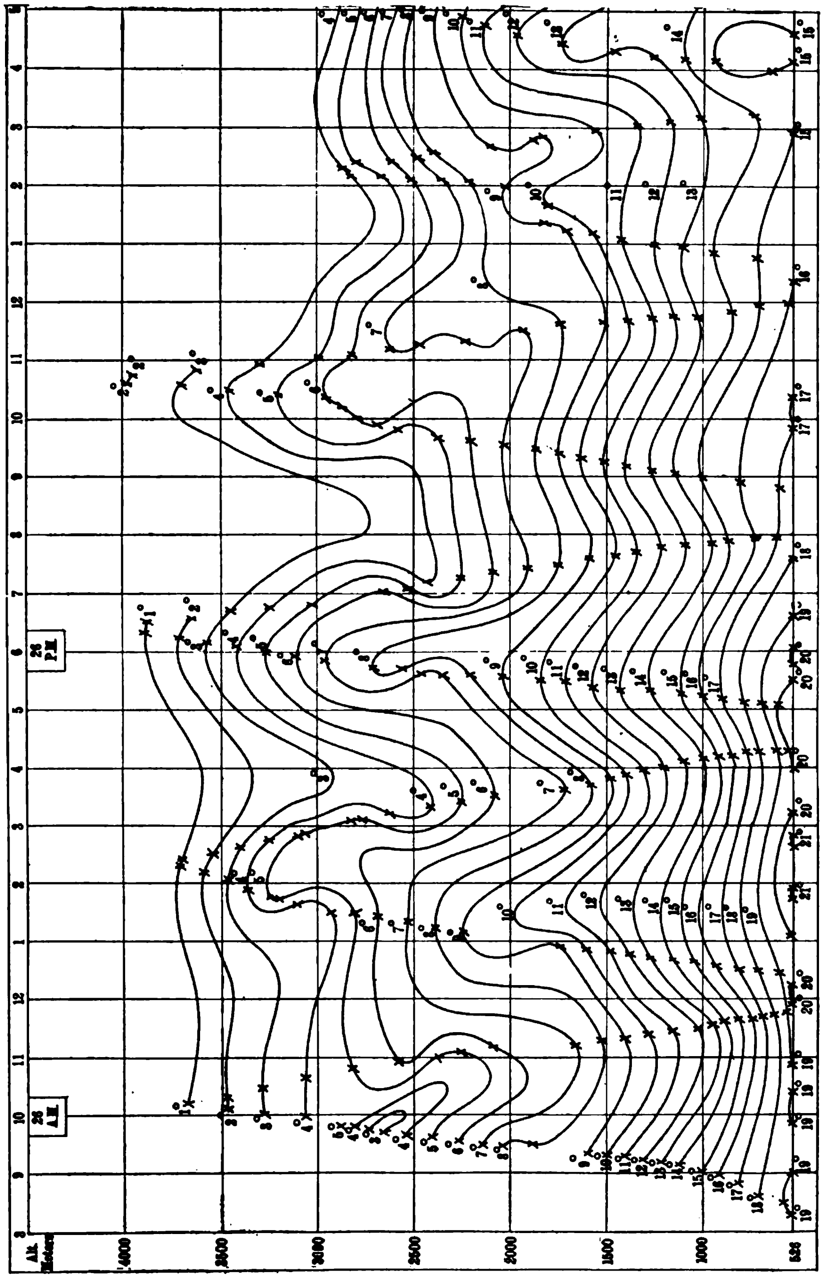


FIG. 2a.—Free air isotherms above Mount Weather; observed July 26, 27, 28, 1912.

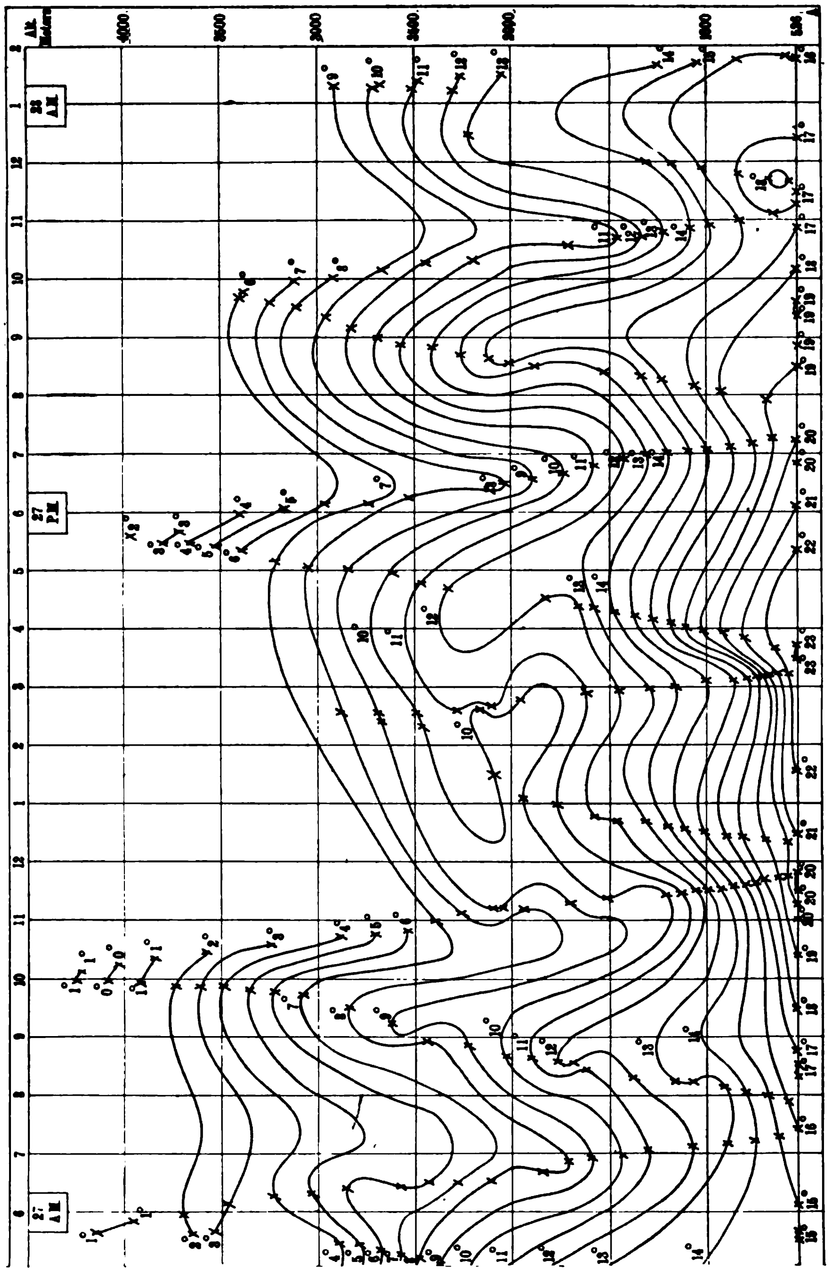


FIG. 2b.—Free air isotherms above Mount Weather; observed July 26, 27, 28, 1912.

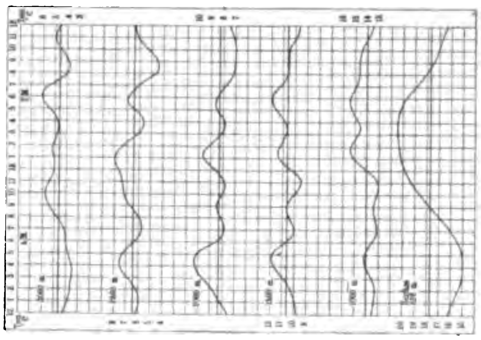


FIG. 3.—Smoothed diurnal curves of temperature above Mount Weather; observed 10.30 a. m., July 26 to 10.30 a. m., July 27, 1912.

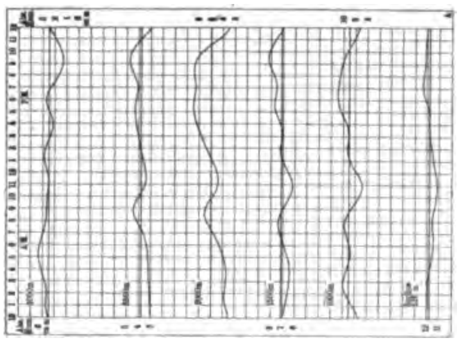


FIG. 4.—Smoothed diurnal curves of absolute humidity above Mount Weather; observed 10.30 a. m., July 26 to 10.30 a. m., July 27, 1912.

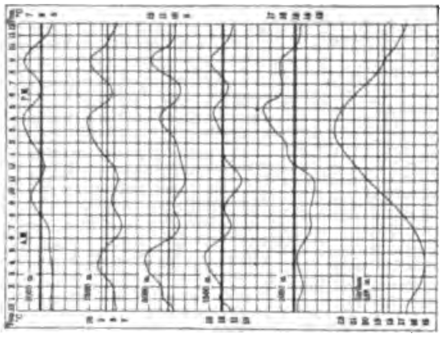


FIG. 5.—Smoothed diurnal curves of temperature above Mount Weather; observed July 27, 1912.

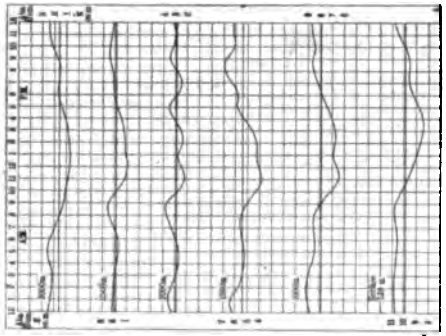


FIG. 6.—Smoothed diurnal curves of absolute humidity above Mount Weather; observed July 27, 1912.

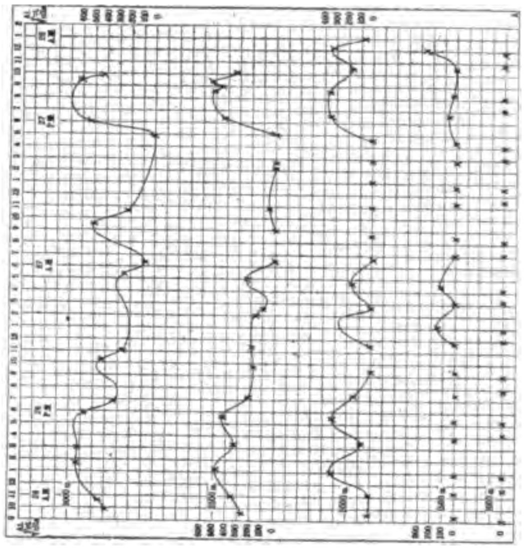


FIG. 8.—Atmospheric potentials above Mount Weather; observed July 26, 27, 28, 1912.

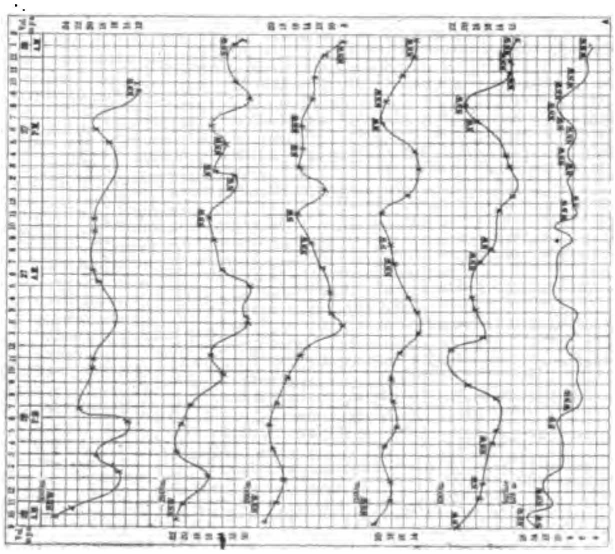


FIG. 7.—Wind velocities and directions above Mount Weather; observed July 26, 27, 28, 1912.

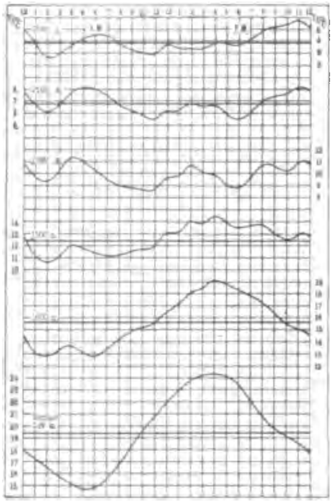


FIG. 10.—Smoothed diurnal curves of temperature above Mount Weather; observed 12.30 p. m., July 29 to 12.30 p. m., July 30, 1912.

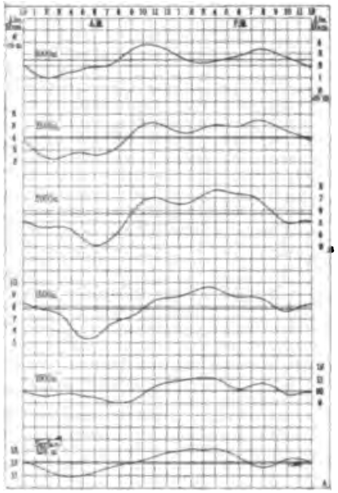


FIG. 11.—Smoothed diurnal curves of absolute humidity above Mount Weather; observed 12.30 p. m., July 29 to 12.30 p. m., July 30, 1912.

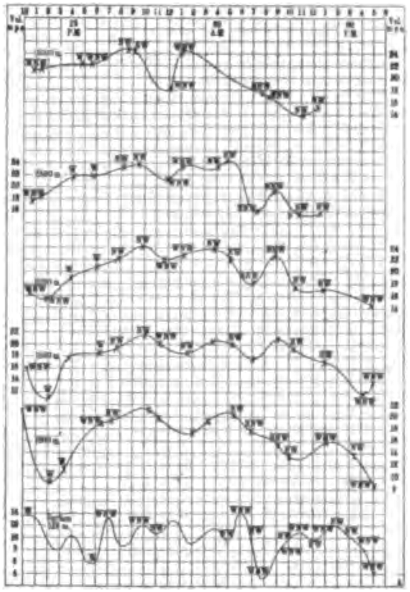


FIG. 12.—Wind velocities and directions above Mount Weather; observed July 29, 30, 1912.

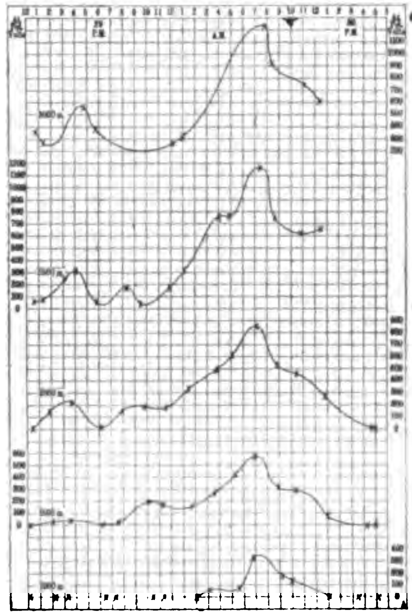
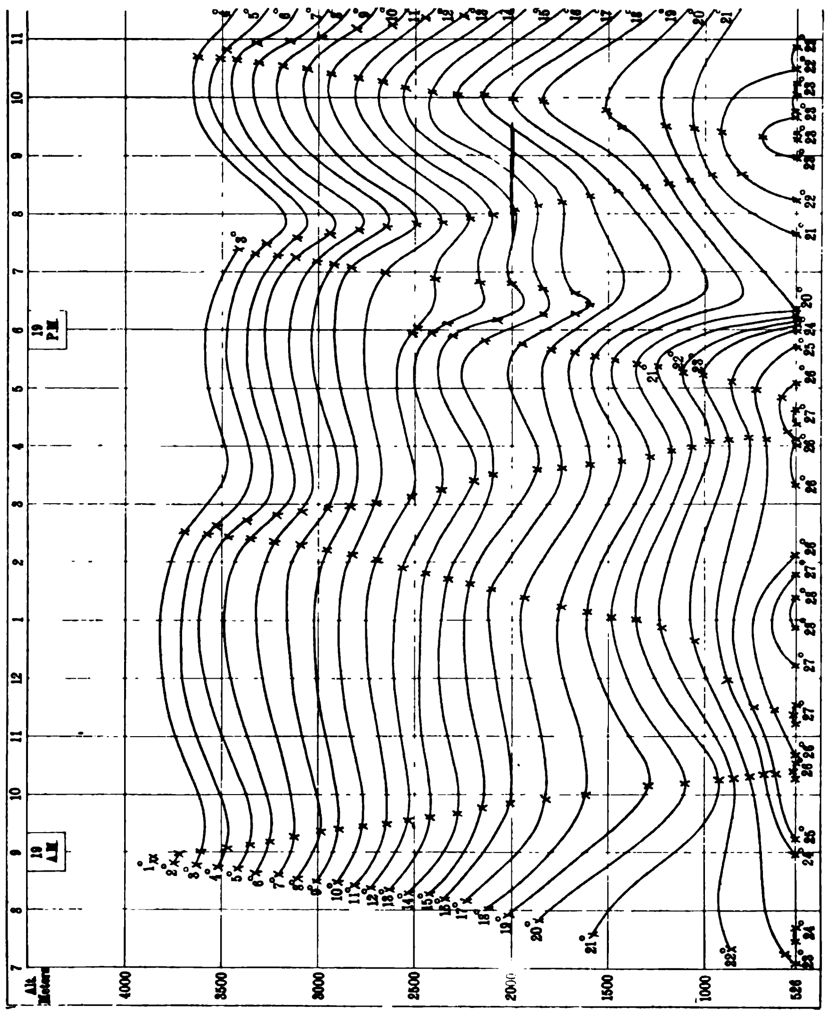


FIG. 13.—Atmospheric potentials above Mount Weather; observed July 29, 30, 1912.



14a.—Free air isotherms above Mount Weather; observed August 19, 20, 1912.

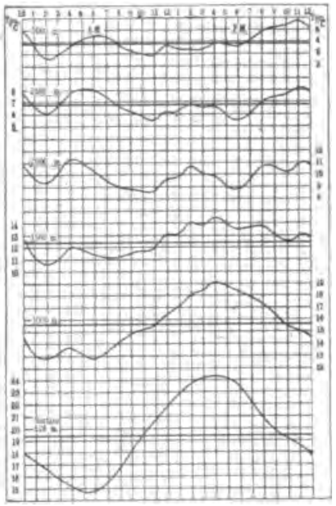


FIG. 10.—Smoothed diurnal curves of temperature above Mount Weather; observed 12.30 p. m., July 29 to 12.30 p. m., July 30, 1912.

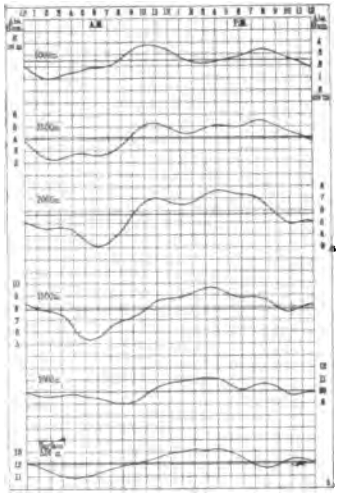


FIG. 11.—Smoothed diurnal curves of absolute humidity above Mount Weather; observed 12.30 p. m., July 29 to 12.30 p. m., July 30, 1912.

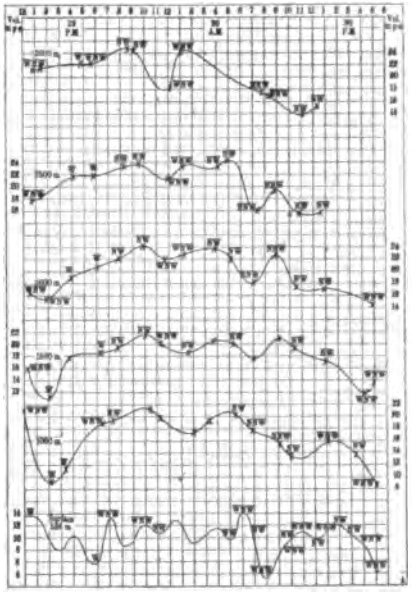


FIG. 12.—Wind velocities and directions above Mount Weather; observed July 29, 30, 1912.

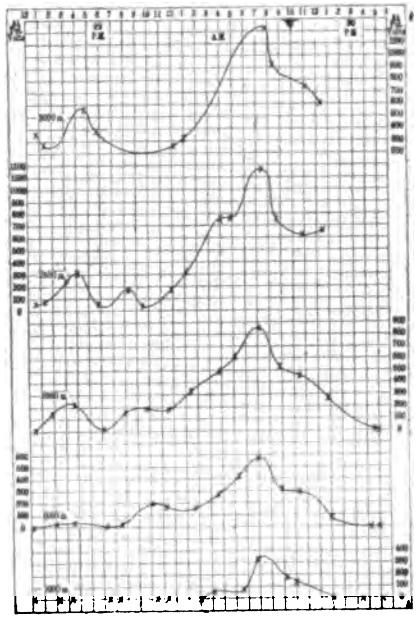


FIG. 13.—Atmospheric potentials above Mount Weather; observed July 29, 30, 1912.

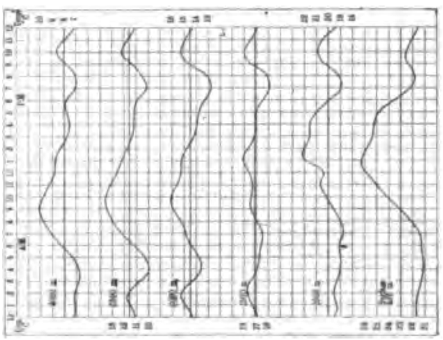


Fig. 15.—Smoothed diurnal curves of temperature above Mount Weather; observed 11.30 a. m., August 19 to 11.30 a. m., August 20, 1912.

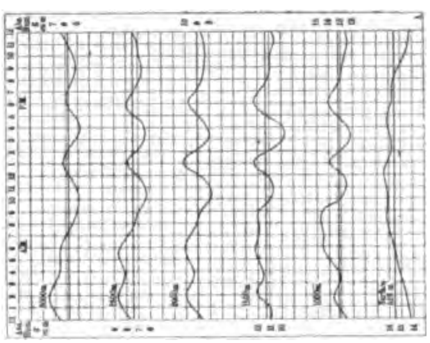


Fig. 16.—Smoothed diurnal curves of absolute humidity above Mount Weather; observed 11.30 a. m., August 19 to 11.30 a. m., August 20, 1912.

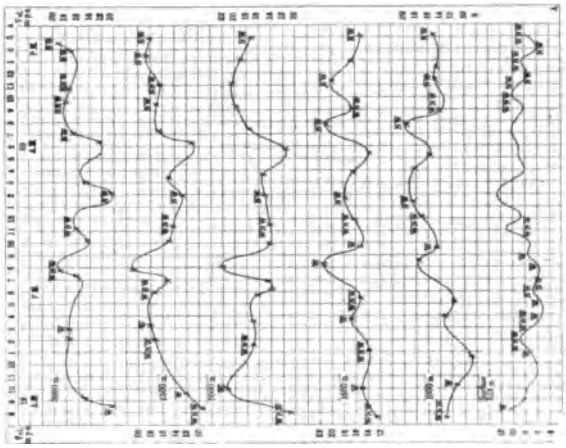


Fig. 17.—Wind velocities and directions above Mount Weather; observed August 19, 20, 1912.

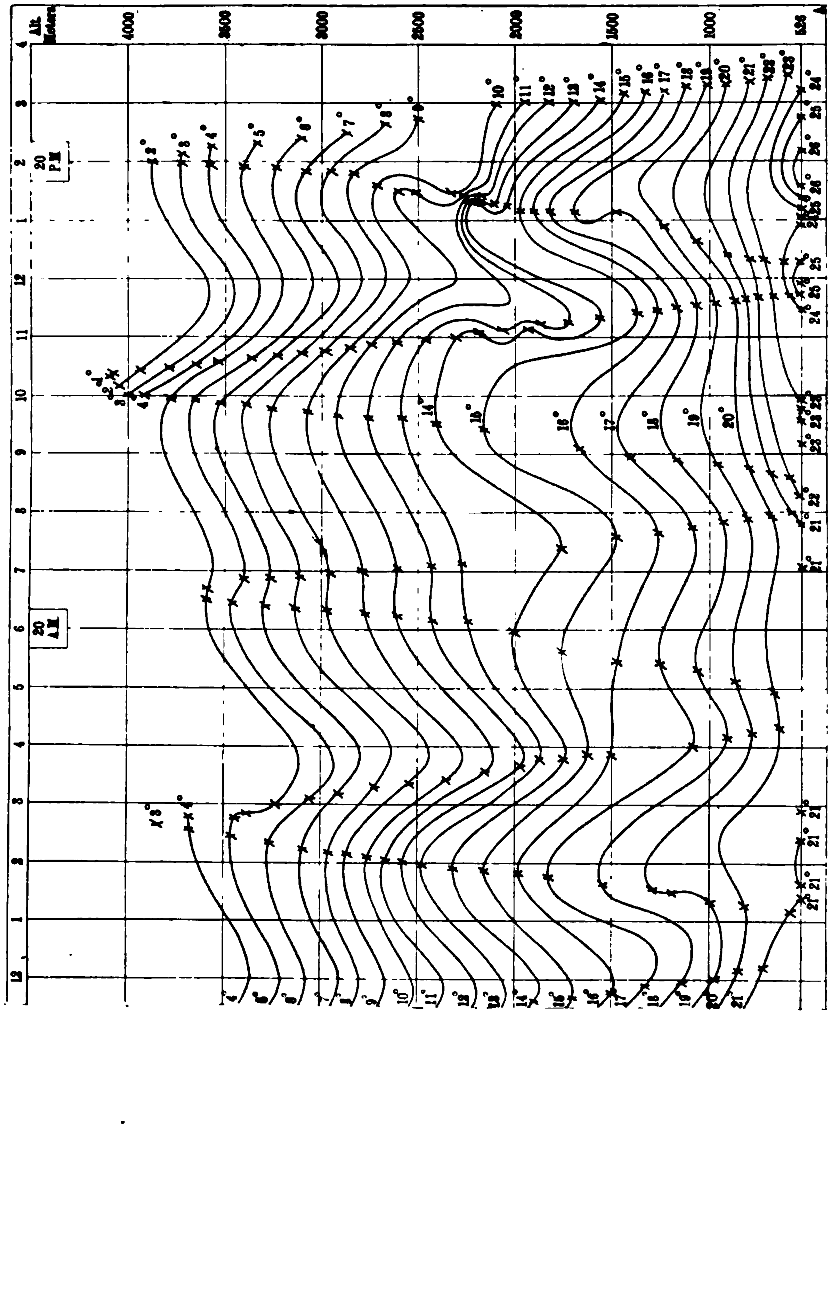


FIG. 14b.—Free air isotherms above Mount Weather; observed August 19, 20, 1912.

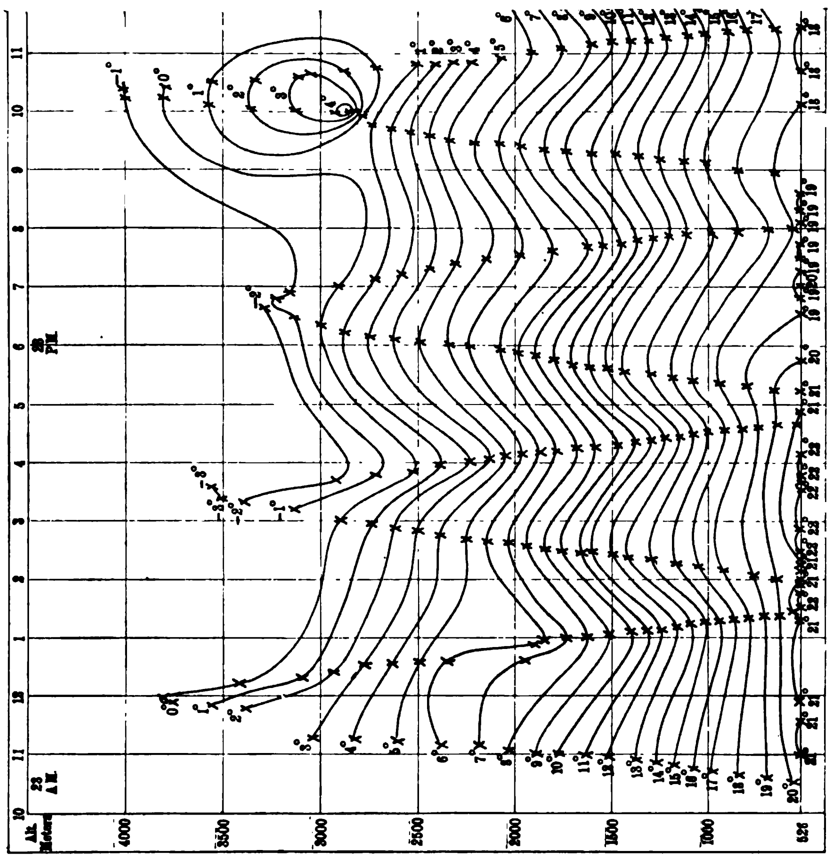


FIG. 19a.—Free air isotherms above Mount Weather; observed August 23, 24, 1912.

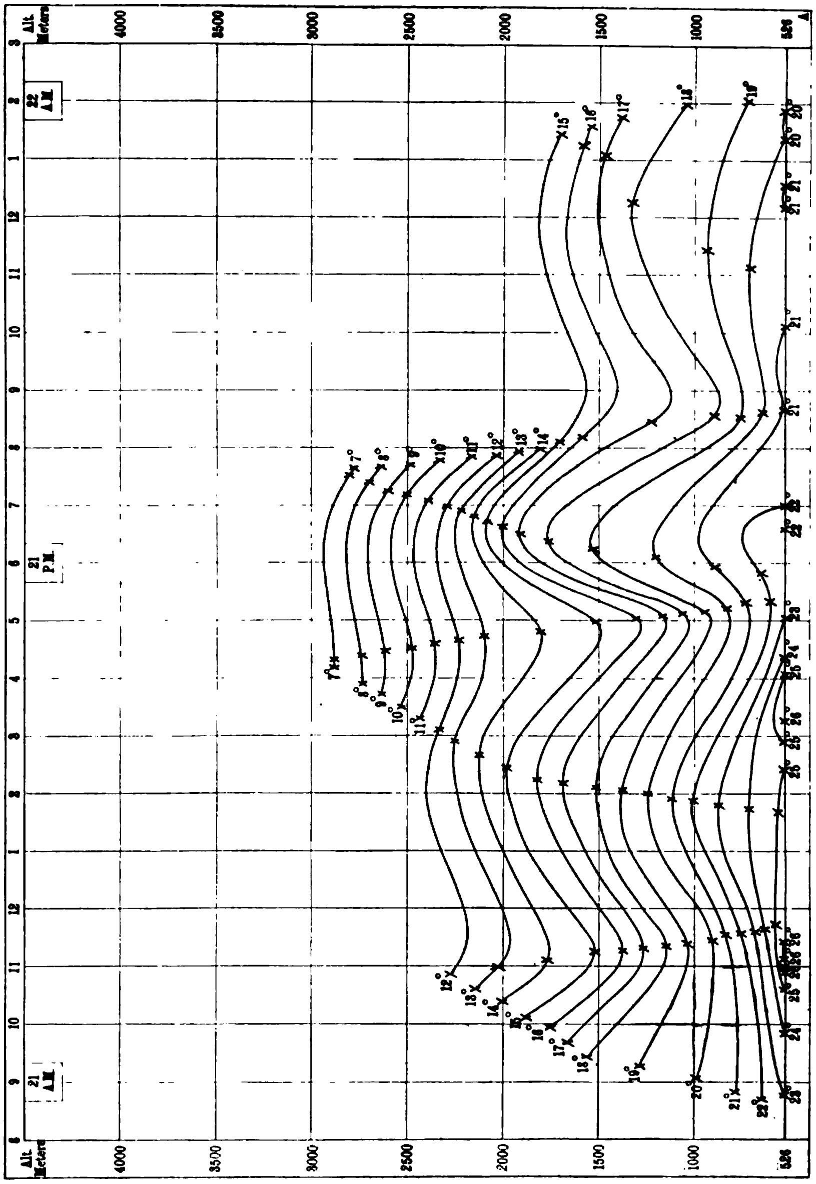


FIG. 18.—Free air isotherms above Mount Weather; observed August 21, 22, 1912.

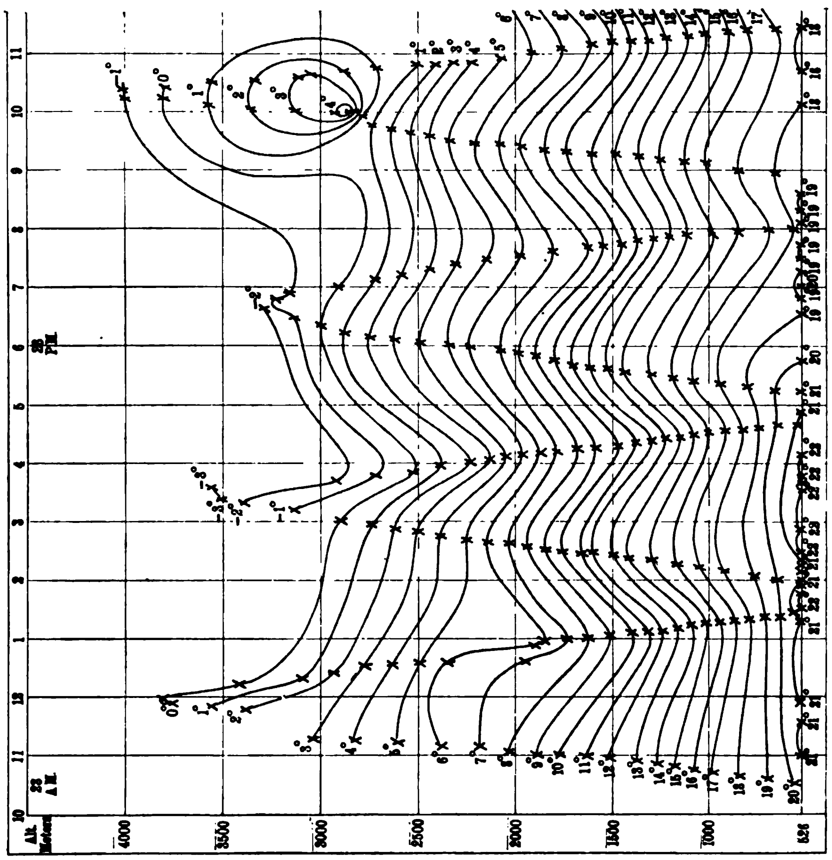


FIG. 19a.—Free air isotherms above Mount Weather; observed August 23, 24, 1912.

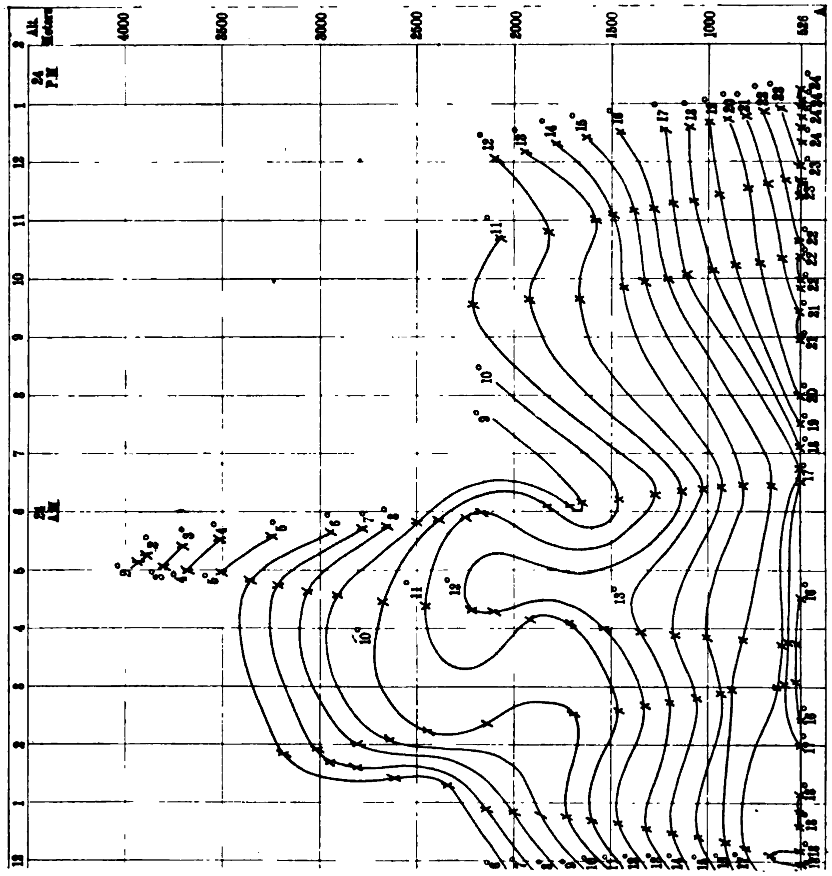


FIG. 19b.—Free air isotherms above Mount Weather; observed August 23, 24, 1912.

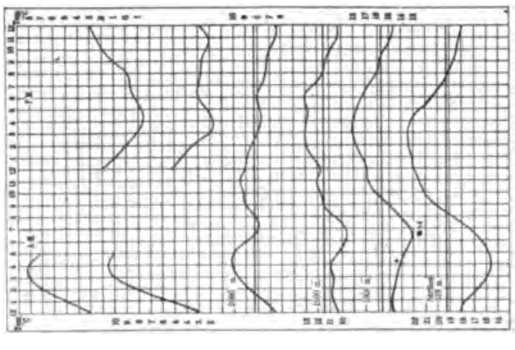


FIG. 20. Smoothed diurnal curves of temperature above Mount Weather; observed 11.30 a. m. August 23 to 11.30 a. m., August 24, 1912.

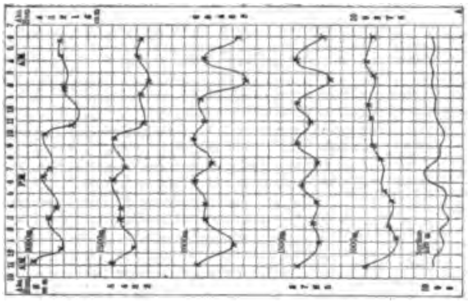


FIG. 21.—Absolute humidities above Mount Weather; observed August 23, 24, 1912.

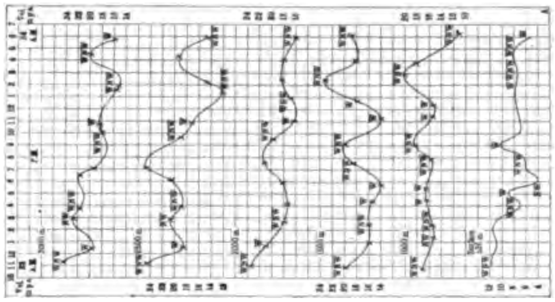


FIG. 22.—Wind velocities and directions above Mount Weather; observed August 23, 24, 1912.

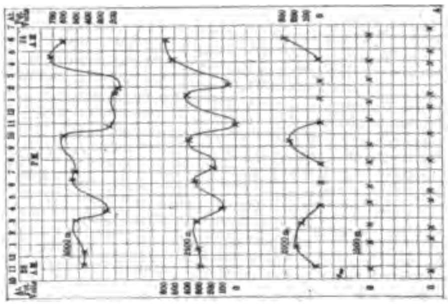


FIG. 23.—Atmospheric potentials above Mount Weather; observed August 23, 24, 1912.

Solar radiation intensities.—In connection with the summary of the Washington pyrheliometric observations for the five years ending with April, 1910, and published in this bulletin, volume 3, there was given in figure 3, page 111, a diagram which showed marked depressions in solar radiation intensities at various places in the years 1884 to 1886, inclusive, 1891, and 1903. This diagram is here reproduced in figure 1, except that Trace IV has been modified so as to show the average radiation intensities for the half-year periods January to June, inclusive, and July to December, inclusive, and has been brought down to the end of 1912. In making this extension there have been utilized measurements made with an Ångström pyrheliometer at Washington, D. C., between May, 1910, and February, 1912, inclusive, and summarized in Table 1, and the measurements made at this observatory, which are summarized in Table 2.

Solar radiation measurements were commenced at Mount Weather on September 21, 1907, with an Ångström pyrheliometer, and some of the earlier results were published in this bulletin, volume 1, page 225. Very few measurements were made during 1910, but in May, 1911, they were resumed with a Marvin pyrheliometer, which is very conveniently exposed on the third floor of the Physical Laboratory Building, during the morning from a window that faces southeast, and in the afternoon from a window that faces southwest.

There is practically no local smoke in the vicinity of Mount Weather.

The Marvin pyrheliometers have been standardized by comparison with Smithsonian silver disk pyrheliometer No. 1, which has itself been repeatedly compared with the substandards at the Astrophysical Observatory of the Smithsonian Institution. In this way a uniform standard of pyrheliometry has been maintained for Mount Weather, and our confidence in the work of Mr. Abbot and his assistants leads us to believe that the radiation intensities summarized in Tables 1 and 2 are expressed in absolute units with a probable error of less than 1 per cent.

The intensities measured with the Ångström pyrheliometer have been reduced to the Smithsonian standard by dividing by 0.95.[1] In reducing the readings of Smithsonian silver disk pyrheliometer No. 1, the old factor, 0.3709, has been employed. In Smithsonian Pyrheliometry Revised[2] the new factor is 0.3683, or less than 1 per cent lower than the old.

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[1] See this bulletin, vol. 5, p. 175.

[2] Abbot, C. G., and Aldrich, L. B., Smithsonian Pyrheliometry Revised. Smithsonian Miscellaneous Collections, vol. 60, No. 18.

It has been my custom to time the pyrheliometric readings so that they should correspond to an air mass that is some multiple of 0.5. Whenever interpolation has been necessary in order to obtain radiation intensities corresponding exactly to these air masses, it has been accomplished graphically as shown in this bulletin, volume 3, page 91. Consult also pages 93 and 94 of the same volume for the method of computing the air mass.

The percentages plotted in Trace IV, figure 1, have been obtained by dividing the a. m. and p. m. average radiation intensities for each month, with the sun at 60° zenith distance, by the corresponding monthly means given in this bulletin, volume 5, page 182, Table 3, and then taking the mean of all the percentages thus obtained in a half-year period, giving each a weight equal to the number of measurements upon which it was based. When measurements made at Mount Weather have been employed, due regard has been had for the apparent ratio between radiation intensities at Mount Weather and Washington.

For the second half of 1910 it was necessary to compare radiation measurements made at Madison, Wis., with those made at the same place in 1911.

While the percentages obtained in this way are not so exact as they would have been if the radiation measurements had all been made at one place, and it can not be claimed that apparent minor variations from period to period are real, the accuracy is sufficient to fix beyond question a diminution in 1907 of solar radiation intensities measured in Washington, and a marked diminution in the second half of 1912 of solar radiation intensities measured at Mount Weather.

The radiation intensities measured at Madison, Wis., during the second period, with the sun at zenith distance 60°, average only 86 per cent of the mean for the corresponding period in the years 1910 and 1911.

At Lincoln, Nebr., the radiation intensities measured in November, 1912, with the sun at zenith distance 60°, average only 82 per cent of the corresponding intensities measured in November, 1911.

Polarization of skylight.—In a previous paper [1] it was shown that during the years 1903 and 1907, when solar-radiation intensities were below normal, the percentage of polarization of skylight was also below normal. Table 3 shows that this was likewise the case during the second half of 1912, the monthly departures being even larger than in 1903.

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[1] This bulletin, vol. 3, p. 114, Table 16.

From Table 4 it is seen that the abnormalities in radiation intensities and in sky polarization in 1912 affect the extreme as well as the mean values.

Position of the neutral points of Arago and Babinet.—In figure 1, Trace V shows that periods of decreased solar-radiation intensity have been accompanied and followed by a marked increase in the solar distance of Babinet's neutral point at about the time of sunrise or sunset.[1] At the same time there has been a less-marked increase in the antisolar distance of Arago's neutral point. As is well known, Babinet's point is affected more by the atmospheric conditions than is Arago's.

The true character of the displacement of the neutral points is not shown as clearly in Trace V, figure 1, as it is in Tables 5 and 6, in which are summarized all my observations on the positions of these points. The altitude of the sun has been computed from its hour angle and declination, and the latitude of the place of observation. The altitude of the neutral points has been measured by means of a Savart polariscope mounted on a pendulum quadrant as described and illustrated by Busch and Jensen.[2]

My first observations on Arago's neutral point were made at Washington in January, 1910, and my first observations on Babinet's neutral point were made at Madison, Wis., in July, 1910. In September of the same year observations on both points were made at Santa Fe, N. Mex., and at Flagstaff, Ariz., and likewise during the following month at Phoenix, Ariz. In October and November, 1912, similar observations were obtained at Santa Fe, N. Mex., and on Lake Peake, near Santa Fe, at an elevation of 12,200 feet (3,700 meters). Observations have been made at Mount Weather since May, 1911.

All the observations have been made when the sky was practically free from clouds.

The data in Tables 5 and 6 show that the antisolar and the solar distances of the neutral points of Arago and Babinet, respectively, are somewhat less in the dry and elevated regions of the southwestern part of the United States than in the humid eastern portions. They also show that these distances were considerably increased in both regions in the second half of 1912, and that the increase was most pronounced when the sun was above the horizon. Indeed, with the

[1] See Busch, Friedr., and Jensen, Chr., Tatsachen und Theorien der atmosphärischen Polarisation, pp. 8, 244, and 247, for the data for Trace V for the years 1886 to 1909, inclusive. For the years 1910 to 1912, the data have been obtained from Table 6.

[2] Ibid., p. 293.

sun well below the horizon there was practically no increase, and on July 27 observations on Arago's neutral point showed a decrease in the antisolar distance with the sun below the horizon as compared with the average of observations for the preceding year. This is in accord with observations made at numerous points in Europe,[1] except that there the decreased solar and antisolar distances of the two points, respectively, with the sun below the horizon, were pronounced for a considerable period.

Jensen [2] is of the opinion that the change produced by the haze in the color of both direct sunlight and diffuse skylight had an important part in shifting the position of the neutral points. There is abundant evidence of this change in color.[3]

As directly connected with the increased solar and antisolar distances of these points before sunset, he also refers to the simultaneously observed decrease in the intensity of direct solar radiation and the increase in diffuse sky radiation. There would presumably result an increase in the negatively or horizontally polarized component of skylight, which would tend to raise the points at which positively and negatively polarized light would produce neutral polarization.

As directly connected with the decreased solar and antisolar distances of these points with the sun below the horizon, he refers to observations made by E. C. Pickering in 1884 after the eruption of Krakatoa, and by myself in 1903 after the eruption of Mount Pelée and other volcanoes in the West Indies and in Central America, which show an increase of nearly 100 per cent in the polarization of skylight near the zenith during the first 20 or 30 minutes after sunset. Observations that he himself made[4] in 1895–96, when the atmosphere was probably free from volcanic dust, showed only a slight increase in sky polarization after sunset, and this was also true of measurements made by me in 1909, which was also a dust-free period. On the other hand measurements made at Mount Weather early in 1913 show an increase in skylight polarization after sunset nearly equal to that observed in 1903. We would expect a rapid increase in the positive or vertically polarized component of skylight to be accompanied by a lowering of the points at which the positively and negatively polarized components would produce neutral polarization.

[1] Jensen, Dr. Chr., Über die grosse atmosphärisch-optische Störung von 1912, pp. 10–11 (Separatabdruck aus den Mitteilungen der Vereinigung von Freunden der Astronomie und kosmischen Physik).

[2] Loc. cit., p. 12.

Kimball, H. H., The Effect upon Atmospheric Transparency of the Eruption of Katmai Volcano: Monthly Weather Review, January, 1913.

[4] Busch, Friedr., and Jensen, Chr., Tatsachen und Theorien der atmosphärischen Polarisation, p. 229.

Temperature departures.—In figure 1, Trace VI shows the average departure of the annual mean temperature from the normal, for the following 17 stations:

Albany, N. Y.; Atlanta, Ga.; Shreveport, La.; Columbus, Ohio; Springfield, Ill.; La Crosse, Wis.; Bismarck, N. Dak.; Huron, S. Dak.; Helena, Mont.; Cheyenne, Wyo.; Dodge City, Kans.; El Paso, Tex.; Santa Fe, N. Mex.; Yuma, Ariz.; Sacramento, Cal.; Salt Lake City, Utah; and Spokane, Wash.

These stations have been selected so as to represent the temperature of all parts of the United States except those in the immediate vicinity of the Great Lakes and on the sea coast.

As noted in this Bulletin (Vol. 3, p. 115), there are depressions of unusual duration in the temperature trace VI, corresponding to the three great depressions culminating in 1885, 1891, and 1903, respectively, in the radiation-intensity trace. It will be of interest to observe if low temperatures result from the present depression in the radiation-intensity trace.

There seems to be ground for anticipating that this will be the case. While the loss of heat during these periods of decreased solar radiation-intensity is not so great as is indicated by Traces I–IV, inclusive, on account of the increase in the quantity of diffuse sky radiation, yet there must be a distinct decrease in the amount of heat received in the lower strata of the atmosphere. One of the first effects of this would be a modification of the atmospheric circulation, on account of which some places might experience higher temperatures than the average while other places were cooler. On the whole, however, we would expect the mean temperature of the hemisphere to be below the normal.

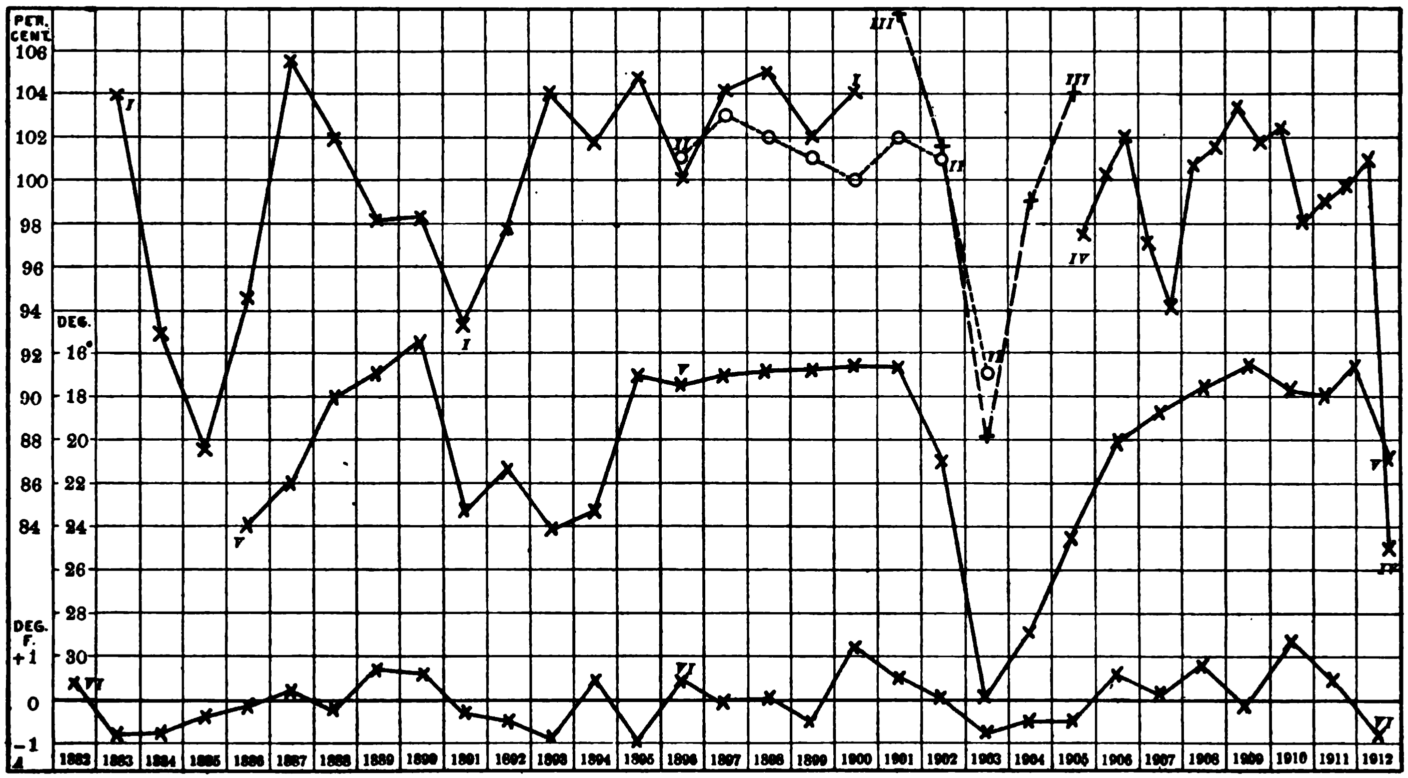

Figure 1.—Traces I, II, III, and IV = annual means of solar radiation intensities at the surface of the earth, expressed as percentages of the general mean for each station. I = Montpelier, France, at noon; II = Lausanne, Switzerland, at noon; III = Warsaw, Russia, with the sun at 60° zenith distance; IV = Washington, D. C., and Mount Weather, Va., with the sun at 60° zenith distance. Trace V = mean solar distance of Babinet's neutral point in degrees of arc, with sun on the horizon. Trace VI = annual mean departures of temperature for the United States in Fahrenheit degrees.

TABLE 1.—*Solar radiation intensities at Washington, D. C., expressed in gram calories per minute per square centimeter of normal surface.*

[Means for less than 3 series of observations are included in brackets.]

Date.	Air mass.				
	1.0	1.5	2.0	2.5	3.0
1910.					
May 5, a. m.	1.51	1.37	1.25	1.13	
May 6, p. m.	1.45	1.27	1.11	0.92	0.78
May 17, p. m.	1.39				
May 19, p. m.	1.42	1.25	1.02		
May 28, noon	1.34				
Means	1.42	1.30	1.13	[1.02]	[0.78]
June 2, noon	1.42				
Dec. 13, p. m.			1.36	1.27	1.18
Dec. 15, noon			1.26		
Dec. 16, p. m.			1.39	1.14	1.01
Dec. 27, p. m.			1.29	1.23	
Means			1.32	1.21	[1.10]
1911.					
Jan. 4, p. m.			1.32	1.25	
Jan. 10, p. m.			1.35	1.19	
Jan. 23, p. m.			1.29	1.01	
Jan. 24, p. m.			1.30	1.21	1.09
Jan. 25, a. m.			1.11		
Jan. 25, p. m.			1.16	0.76	
Jan. 28, p. m.			1.39	1.28	1.12
Means			1.27	1.12	[1.10]
Feb. 1, a. m.		1.39	1.26		
Feb. 21, a. m.		1.51			
Feb. 23, p. m.		1.48	1.32	1.18	1.08
Means		1.46	[1.29]	[1.18]	[1.08]
Mar. 3, p. m.		1.32			
Mar. 10, p. m.		1.17	0.98	0.83	0.75
Mar. 15, noon		1.19			
Mar. 17, noon		1.26			
Mar. 20, p. m.		1.29			0.91
Mar. 21, a. m.		1.25	1.01		
Mar. 21, p. m.		1.27	1.06	0.90	
Mar. 24, p. m.		1.43	1.30	1.17	1.04
Means		1.27	1.09	0.97	0.90
Apr. 10, p. m.	1.48	1.34	1.24	1.15	
Apr. 18, noon	1.50				
Apr. 25, noon	1.47				
Means	1.48	[1.34]	[1.24]	[1.15]	
June 1, p. m.	1.41				
June 9, p. m.	1.32				
June 10, noon	1.15				
June 12, p. m.		0.82			
June 13, noon	1.29				
June 15, a. m.	1.32				
June 20, a. m.	1.44				
June 20, p. m.	1.27				
June 21, a. m.	1.42				
June 22, a. m.	1.20				
June 22, p. m.	1.29				
June 24, a. m.	1.11				
June 24, p. m.	1.15				
June 29, p. m.	1.35				
June 30, a. m.	1.37				
June 30, p. m.	1.41				
Means	1.30	[0.82]			

TABLE 1.—*Solar radiation intensities at Washington, D. C., expressed in gram calories per minute per square centimeter of normal surface*—Continued.

Date.	Air mass.				
	1.0	1.5	2.0	2.5	3.0
1911.					
July 5, a. m.	1.29	......	......	......	......
July 6, a. m.	1.31	......	......	......	......
July 7, a. m.	1.00	......	......	......	......
July 10, a. m.	1.31	......	......	......	......
July 22, a. m.	1.24	......	......	......	......
July 25, a. m.	1.47	......	......	......	......
July 25, p. m.	1.47	......	......	......	......
Means	1.30	......	......	......	......
Aug. 10, a. m.	1.26	1.05	......	......	......
Aug. 11, a. m.	1.25	1.04	......	......	......
Aug. 16, a. m.	......	1.16	......	......	......
Aug. 19, a. m.	1.42	......	......	......	......
Aug. 21, a. m.	1.35	1.16	......	......	......
Aug. 21, p. m.	......	1.16	......	......	......
Aug. 22, p. m.	......	1.15	......	......	......
Aug. 23, noon	1.11	......	......	......	......
Means	1.28	1.12	......	......	......
Nov. 3, a. m.	......	......	1.18	......	......
Nov. 11, a. m.	......	......	1.21	......	......
Nov. 11, p. m.	......	......	1.13	......	......
Nov. 16, a. m.	......	......	1.24	......	......
Means	......	......	1.19	......	......
Dec. 4, p. m.	......	......	......	1.31	......
Dec. 5, p. m.	......	......	......	......	1.09
Dec. 6, p. m.	......	......	......	1.11	......
Means	......	......	......	[1.21]	[1.09]
1912.					
Jan. 9, a. m.	......	......	1.23	1.11	......
Jan. 9, p. m.	......	......	1.29	......	......
Jan. 10, p. m.	......	......	......	1.30	......
Means	......	......	[1.26]	[1.20]	......
Feb. 13, p. m.	......	......	......	1.13	......

TABLE 2.—*Solar radiation intensities at Mount Weather, Va., expressed in gram calories per minute per square centimeter of normal surface.*

Date.	Air mass.										
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
1908.											
Jan. 2, a. m.	......	......	1.40	1.28	1.18	1.08	0.99	......	......	......	......
Jan. 5, a. m.	......	......	1.35	1.24	1.14	1.05	......	......	......	......	......
Jan. 9, a. m.	......	......	1.26	1.15	1.05	......	......	......	......	......	......
Jan. 15, a. m.	......	......	1.34	1.24	1.15	......	......	......	......	......	......
Jan. 17, a. m.	......	......	1.31	1.21	1.12	1.05	0.97	0.90	0.84	......	......
Jan. 19, a. m.	......	......	1.30	1.20	1.11	......	......	......	......	......	......
Jan. 22, a. m.	......	......	1.38	1.26	1.15	1.05	0.96	......	......	......	......
Jan. 30, a. m.	......	......	1.32	1.26	1.20	1.14	1.08	......	......	......	......
1910.											
Jan. 8, a. m.	......	......	1.38	1.31	1.25	1.19	1.13	1.07	1.02	0.98	......
Means	......	......	1.34	1.24	1.15	1.09	1.03	[0.98]	[0.93]	[0.98]	......

TABLE 2.—*Solar radiation intensities at Mount Weather, Va., expressed in gram calories per minute per square centimeter of normal surface*—Continued.

Date.	Air mass.										
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
1908.											
Jan. 5, p. m.			1.25	1.15	1.05	0.99	0.92				
Jan. 6, p. m.			1.34	1.24	1.15	1.05	0.99	0.92			
Jan. 14, p. m.			1.33	1.23	1.13	1.05	0.96	0.89	0.82		
Jan. 17, p. m.			1.29	1.19	1.11	1.02	0.95	0.88	0.82		
Jan. 19, p. m.			1.30	1.20	1.11						
Jan. 22, p. m.			1.26	1.16	1.06	0.97	0.91	0.86	0.82		
1910.											
Jan. 8, p. m.				1.30	1.22	1.15	1.08	1.06			
Means			1.30	1.21	1.12	1.04	0.97	0.92	0.82		
1908.											
Feb. 8, a. m.		1.42	1.30	1.18	1.08						
Feb. 29, a. m.		1.28	1.15								
1910.											
Feb. 7, a. m.				1.30	1.22		1.08	1.02	0.99		
Means		[1.35]	[1.22]	[1.24]	[1.15]		[1.08]	[1.02]	[0.99]		
1908.											
Feb. 6, p. m.		1.37	1.24	1.12	1.01	0.91					
Feb. 8, p. m.			1.28	1.17	1.06	0.93	0.86	0.82	0.78		
Feb. 28, p. m.		1.29	1.10	1.00	0.90	0.84					
1910.											
Feb. 7, p. m.			1.43	1.34	1.27	1.20	1.13				
Feb. 25, p. m.		1.48	1.38	1.29	1.21	1.05					
Means		1.38	1.29	1.18	1.09	0.99	[1.00]	[0.82]	[0.78]		
1908.											
Mar. 11, a. m.		1.34	1.25	1.17	1.09	1.02	0.95	0.89	0.83		
Mar. 12, a. m.		1.13									
1910.											
Mar. 7, a. m.		1.44	1.37	1.29	1.22	1.16	1.11	1.06	1.01	0.96	
Means		1.30	[1.31]	[1.23]	[1.16]	[1.09]	[1.03]	[0.98]	[0.92]	[0.96]	
1908.											
Mar. 10, p. m.		1.21	1.06	0.93	0.82	0.75	0.68	0.62	0.56		
1910.											
Mar. 7, p. m.		1.42	1.23	1.08							
1912.											
Mar. 7, p. m.	1.45	1.34	1.23	1.14	1.05	0.97	0.89	0.82	0.76	0.70	
Means	[1.45]	1.32	1.17	1.05	[0.94]	[0.86]	[0.78]	[0.72]	[0.66]	[0.70]	
1908.											
Apr. 13, a. m.	1.44	1.33	1.23	1.14	1.05	0.97	0.90	0.83			
Apr. 29, a. m.	1.36	1.20	1.07	0.95	0.84						
1909.											
Apr. 24, a. m.	1.30	1.28	1.21	1.12							
Means	1.37	1.27	1.17	1.07	[0.94]	[0.97]	[0.90]	[0.83]			
1908.											
Apr. 12, p. m.	1.48	1.30	1.14	1.00	0.87	0.76					
Apr. 16, p. m.	1.44	1.30	1.18	1.07	0.96	0.91	0.85				
1909.											
Apr. 26, p. m.	1.45	1.31	1.19	1.07	0.97						
Means	1.46	1.30	1.17	1.05	0.93	[0.84]	[0.85]				

TABLE 2.—*Solar radiation intensities at Mount Weather, Va., expressed in gram calories per minute per square centimeter of normal surface*—Continued.

Date.	Air mass.										
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
1908.											
May 1, a. m.	1.26	1.18	1.10	1.02	0.95						
May 2, a. m.	1.20	1.18	1.17	1.15	1.13	1.12					
May 26, a. m.	1.29	1.19	1.09	1.01	0.93	0.86	0.79				
May 27, a. m.	1.25										
1909.											
May 12, a. m.		1.42	1.31	1.21							
May 17, a. m.			1.21	1.11	1.01						
1911.											
May 19, a. m.				0.49							
May 20, a. m.	1.25	1.06	0.87	0.75	0.67	0.58					
May 21, a. m.	1.20	1.02	0.88	0.75	0.65	0.56	0.47	0.43			
May 22, a. m.	1.06	0.87	0.72	0.61	0.52	0.44					
May 23, a. m.		0.96	0.81	0.73	0.64	0.57	0.51	0.46			
May 24, a. m.	1.32										
May 25, a. m.	1.09	1.19	1.06	0.92	0.82	0.72					
1912.											
May 10, a. m.	1.36	1.27	1.19	1.11	1.04	0.97	0.91	0.84	0.80		
May 11, a. m.						0.92	0.87	0.82	0.77		
May 15, a. m.			1.11								
May 17, a. m.		1.28	1.25	1.13	1.00	0.95	0.93	0.87			
May 21, a. m.	1.16	0.98	0.86	0.74	0.65	0.57	0.51	0.47			
May 22, a. m.	1.11	0.96	0.83	0.71	0.62	0.53	0.46	0.40			
May 24, a. m.	1.30	1.11	0.95								
Means	1.22	1.12	1.03	0.90	0.82	0.73	0.67	0.61	[0.78]		
1911.											
May 18, p. m.		0.92	0.66								
May 19, p. m.	1.07										
May 22, p. m.		0.88	0.74								
May 25, p. m.		0.89	0.74	0.59		0.35					
May 26, p. m.	1.07										
1912.											
May 1, p. m.	1.41	1.30	1.19	1.10							
May 2, p. m.	1.08	0.92	0.77	0.62	0.47	0.35					
May 3, p. m.	1.31	1.14	1.06	0.95	0.85						
May 9, p. m.		1.31	1.14	0.95							
May 10, p. m.	1.45	1.19	0.97	0.80	0.65	0.55	0.46				
May 13, p. m.	1.53	1.37	1.26	1.17	1.08	1.00					
May 20, p. m.			1.00	0.77							
May 22, p. m.	1.10	0.98	0.87	0.78	0.69	0.61					
Means	1.25	1.09	0.96	0.86	0.75	0.57	[0.46]				
1908.											
June 2, a. m.	1.44	1.29	1.18	1.09	1.00						
June 3, a. m.	1.21										
June 16, a. m.	1.45	1.29	1.14	1.03	0.93	0.84					
June 24, a. m.	1.31	1.14									
June 27, a. m.		1.10	1.02	0.93	0.85	0.79					
1911.											
June 9, a. m.	1.36	1.22	1.12	0.98	0.88	0.80	0.72	0.63			
June 10, a. m.	1.04	0.92	0.70	0.52							
June 15, a. m.		1.14									
June 21, a. m.	1.48	1.37	1.27				0.94				
June 22, a. m.		1.05	0.97	0.90	0.84						
June 23, a. m.	1.19	1.06	0.95	0.85							
June 24, a. m.	1.19	1.04	0.91	0.80	0.71	0.62	0.55				
June 27, a. m.	1.23	1.14									
June 28, a. m.						0.65	0.51				
June 29, a. m.		1.23	1.08	0.95	0.88	0.73	0.60				
June 30, a. m.	1.44	1.34	1.24	1.16	1.08	1.00	0.93				

TABLE 2.—*Solar radiation intensities at Mount Weather, Va., expressed in gram calories per minute per square centimeter of normal surface*—Continued.

Date.	Air mass.										
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
1912.											
June 8, a. m.	1.39	1.26	1.18	1.10	1.03	0.98	0.87	0.81	......	......	......
June 9, a. m.	1.42	1.36	1.24	1.14	1.05	0.96	0.89	0.81	......	......	......
June 10, a. m.	0.95	0.88	0.83	0.76	0.71	0.66	......	......	......	......	......
June 11, a. m.	0.99	0.77	0.62	0.50	0.42	0.34	0.28	......	......	......	......
June 12, a. m.	1.34	1.19	1.05	0.93	0.84	0.77	0.71	......	......	......	......
June 20, a. m.	1.25	1.11	0.99	0.88	0.78	0.69	0.62	......	......	......	......
June 21, a. m.	1.26	1.12	1.02	0.93	0.85	0.77	0.70	......	......	......	......
Means	1.27	1.14	1.03	0.91	0.86	0.76	0.69	0.75	......	......	......
1908.											
June 12, p. m.	1.24	1.07	0.81	0.70	0.64	......	......	......	......	......	......
June 16, p. m.	1.45	1.33	1.22	1.12	1.03	0.94	......	......	......	......	......
1911.											
June 21, p. m.	......	1.29	1.16	1.03	0.92	0.86	......	......	......	......	......
June 22, p. m.	1.34	1.08	......	......	......	......	......	......	......	......	......
June 23, p. m.	......	......	0.69	......	......	......	......	......	......	......	......
June 28, p. m.	1.18	1.06	1.05	0.98	0.91	0.84	......	......	......	......	......
June 29, p. m.	1.44	1.30	1.15	1.01	0.93	0.84	......	......	......	......	......
1912.											
June 5, p. m.	1.32	0.96	0.84	0.76	0.69	......	......	......	......	......	......
June 6, p. m.	......	1.10	......	......	......	......	......	......	......	......	......
June 10, p. m.	1.06	1.06	1.01	0.91	0.82	0.74	......	......	......	......	......
Means	1.29	1.14	0.99	0.93	0.85	0.84	......	......	......	......	......
1908.											
July 11, a. m.	1.28	1.05	0.87	0.75	0.68	0.65	......	......	......	......	......
July 16, a. m.	1.49	1.38	1.29	1.20	1.12	1.06	0.99	......	......	......	......
1911.											
July 5, a. m.	......	1.06	0.92	0.82	0.74	0.66	......	......	......	......	......
July 6, a. m.	1.25	1.21	1.11	1.02	0.95	0.88	0.82	......	......	......	......
July 7, a. m.	1.02	0.89	0.79	0.69	0.59	0.54	......	......	......	......	......
July 10, a. m.	1.32	1.21	1.10	......	......	......	......	......	......	......	......
July 11, a. m.	1.27	1.14	1.01	0.86	0.82	0.79	0.77	0.72	......	......	......
July 13, a. m.	......	1.05	0.89	0.76	0.68	0.64	0.60	......	......	......	......
July 15, a. m.	......	1.21	1.09	0.99	0.90	0.81	0.75	......	......	......	......
July 20, a. m.	1.26	......	......	......	......	......	......	......	......	......	......
July 21, a. m.	......	......	......	0.73	0.64	0.56	......	......	......	......	......
July 22, a. m.	1.32	1.04	......	......	......	......	......	......	......	......	......
July 24, a. m.	......	......	1.03	......	......	......	......	......	......	......	......
July 25, a. m.	1.50	1.37	1.31	1.23	1.16	1.10	1.03	0.98	......	......	......
July 26, a. m.	1.32	1.19	......	......	......	0.82	0.76	......	......	......	......
July 27, a. m.	1.26	1.10	0.81	......	......	......	......	......	......	......	......
July 28, a. m.	......	1.04	0.89	......	0.71	0.63	......	......	......	......	......
July 29, a. m.	......	1.10	0.91	......	......	......	......	......	......	......	......
1912.											
July 3, a. m.	1.23	1.05	0.89	......	......	......	......	......	......	......	......
July 6, a. m.	1.14	0.97	0.83	0.72	0.63	0.56	0.50	0.44	......	......	......
July 7, a. m.	1.11	0.95	0.82	0.71	0.62	0.54	0.47	......	......	......	......
July 8, a. m.	1.12	0.96	0.84	0.75	0.65	0.58	0.51	0.45	......	......	......
July 9, a. m.	......	1.05	0.93	0.82	0.73	......	......	......	......	......	......
July 11, a. m.	......	0.94	......	......	......	......	......	......	......	......	......
July 12, a. m.	......	0.80	0.69	......	......	......	......	......	......	......	......
July 13, a. m.	......	0.85	......	......	0.44	0.35	0.28	......	......	......	......
July 19, a. m.	1.24	......	0.89	......	......	......	......	......	......	......	......
July 23, a. m.	......	0.81	0.70	0.63	0.54	0.45	0.38	0.32	......	......	......
July 27, a. m.	1.21	0.99	0.84	......	......	0.55	......	......	......	......	......
July 28, a. m.	......	1.03	0.88	......	0.64	0.55	0.48	......	......	......	......
July 30, a. m.	0.69	0.53	......	0.32	......	......	......	......	......	......	......
Means	1.22	1.04	0.93	0.81	0.74	0.67	0.64	0.58	......	......	......

TABLE 2.—*Solar radiation intensities at Mount Weather, Va., expressed in gram calories per minute per square centimeter of normal surface*—Continued.

Date.	Air mass.										
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
1911.											
July 3, p. m.	1.15	0.96	......	......	......	......	......	......	......	......	......
July 5, p. m.	1.31	1.19	1.09	1.01	0.86	......	......	......	......	......	......
July 6, p. m.	......	0.91	......	......	......	......	......	......	......	......	......
July 12, p. m.	1.36	1.18	1.00	0.91	0.79	......	......	......	......	......	......
July 13, p. m.	1.19	1.13	1.08	......	......	......	......	......	......	......	......
July 14, p. m.	......	1.07	0.84	......	......	......	......	......	......	......	......
July 25, p. m.	......	1.29	1.14	1.05	......	......	......	......	......	......	......
July 28, p. m.	1.25	1.01	0.79	......	......	......	......	......	......	......	......
1912.											
July 2, p. m.	1.10	0.90	0.80	0.67	0.58	......	......	......	......	......	......
July 3, p. m.	......	1.01	0.89	0.78	0.68	......	......	......	......	......	......
July 8, p. m.	......	0.99	0.86	0.76	0.67	0.59	......	......	......	......	......
July 9, p. m.	1.18	......	......	......	......	......	......	......	......	......	......
July 19, p. m.	......	0.99	0.93	......	......	......	......	......	......	......	......
July 27, p. m.	......	1.02	0.92	0.74	0.52	0.43	......	......	......	......	......
Means	1.22	1.05	0.94	0.85	0.68	[0.51]	......	......	......	......	......
1908.											
Aug. 4, a. m.	1.36	1.24	1.13	1.03	0.94	0.86	0.79	......	......	......	......
Aug. 11, a. m.	......	1.16	......	......	......	......	......	......	......	......	......
Aug. 19, a. m.	......	1.22	......	......	......	......	......	......	......	......	......
Aug. 30, a. m.	......	1.23	1.14	1.05	0.97	......	......	......	......	......	......
Aug. 31, a. m.	1.29	1.15	1.03	0.93	0.84	......	......	......	......	......	......
1909.											
Aug. 2, a. m.	1.30	1.20	1.10	1.02	0.92	0.86	......	......	......	......	......
Aug. 4, a. m.	1.26	1.15	......	......	......	......	......	......	......	......	......
Aug. 6, a. m.	......	0.86	0.72	0.56	......	......	......	......	......	......	......
Aug. 9, a. m.	......	0.84	......	......	......	......	......	......	......	......	......
Aug. 11, a. m.	1.45	1.33	1.22	1.11	1.02	0.93	0.85	......	......	......	......
Aug. 30, a. m.	1.46	1.36	1.27	1.18	1.10	1.03	0.97	0.91	0.85	......	......
1911.											
Aug. 9, a. m.	1.32	1.02	0.90	......	......	......	......	......	......	......	......
Aug. 10, a. m.	......	1.26	1.16	1.06	0.97	0.91	0.85	0.79	0.74	0.69	......
Aug. 11, a. m.	1.21	1.11	1.01	0.82	0.69	0.60	0.51	0.45	0.38	......	......
Aug. 19, a. m.	......	1.33	1.23	1.15	1.08	1.06	0.96	0.91	0.86	0.81	0.75
Aug. 20, a. m.	1.39	1.24	1.12	1.02	0.94	0.86	......	......	......	......	......
Aug. 21, a. m.	......	1.21	1.08	0.97	0.88	0.80	0.74	0.68	0.63	0.58	0.54
Aug. 22, a. m.	1.37	1.28	1.20	1.12	1.05	0.98	0.92	0.86	0.80	0.75	0.71
Aug. 23, a. m.	......	0.99	0.83	......	......	......	......	......	......	......	......
Aug. 24, a. m.	1.23	0.97	0.77	0.61	......	......	......	......	......	......	......
1912.											
Aug. 4, a. m.	0.97	0.79	0.67	0.58	0.50	0.43	......	......	......	......	......
Aug. 5, a. m.	......	0.88	0.69	0.58	0.48	......	......	......	......	......	......
Aug. 11, a. m.	1.17	0.93	0.79	......	......	......	......	......	......	......	......
Aug. 12, a. m.	......	0.90	......	......	......	......	......	......	......	......	......
Aug. 15, a. m.	......	0.98	......	......	......	......	......	......	......	......	......
Aug. 21, a. m.	......	1.03	0.86	......	......	......	......	......	......	......	......
Aug. 22, a. m.	......	......	0.74	......	......	......	......	......	......	......	......
Aug. 24, a. m.	1.06	0.89	0.74	0.63	0.54	0.47	0.39	......	......	......	......
Aug. 28, a. m.	1.15	0.99	0.86	0.74	......	......	......	......	......	......	......
Aug. 30, a. m.	......	1.03	0.84	0.70	0.61	0.54	0.48	......	......	......	......
Means	1.27	1.09	0.96	0.89	0.85	0.79	0.75	0.77	0.71	0.71	0.67
1908.											
Aug. 31, p. m.	......	1.12	0.98	0.85	0.77	0.71	0.66	......	......	......	......
1909.											
Aug. 2, p. m.	......	......	0.93	0.88	0.82	......	......	......	......	......	......
Aug. 30, p. m.	......	1.27	1.16	1.06	0.99	0.93	......	......	......	......	......
1911.											
Aug. 7, p. m.	1.32	1.13	1.02	0.90	0.82	0.73	0.64	......	......	......	......
Aug. 8, p. m.	1.26	......	......	......	......	......	......	......	......	......	......
Aug. 9, p. m.	......	1.06	0.81	0.78	0.64	......	......	......	......	......	......
Aug. 10, p. m.	1.36	1.24	1.14	1.05	0.98	0.91	0.85	......	......	......	......
Aug. 21, p. m.	1.36	1.22	1.11	1.00	0.90	0.84	0.78	0.73	......	......	......
Aug. 22, p. m.	......	1.26	1.12	1.01	0.91	0.82	0.74	0.67	......	......	......

TABLE 2.—*Solar radiation intensities at Mount Weather, Va., expressed in gram calories per minute per square centimeter of normal surface*—Continued.

Date.	Air mass.										
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
1912.											
Aug. 15, p. m.		0.79									
Aug. 22, p. m.		1.04									
Aug. 24, p. m.		0.91	0.75	0.62	0.54	0.47	0.41	0.35	0.30	0.26	
Aug. 26, p. m.		0.90									
Aug. 30, p. m.		1.14									
Aug. 31, p. m.		0.76									
Means	1.32	1.06	1.00	0.91	0.82	0.77	0.68	0.58	[0.30]	[0.26]	
1907.											
Sept. 21, a. m.		1.21	1.07	0.94	0.83	0.73					
Sept. 24, a. m.		1.31	1.17	1.05	0.94	0.84	0.75				
Sept. 25 a. m.		1.34	1.22	1.11	1.01	0.93	0.84				
1908.											
Sept. 8, a. m.	1.37										
Sept. 9, a. m.		1.35	1.24	1.15	1.07						
Sept. 16, a. m.		1.36	1.29	1.22	1.11	1.06					
Sept. 29, a. m.		1.37	1.27	1.21		1.07	1.00				
1909.											
Sept. 2, a. m.	1.53	1.41	1.30	1.20	1.10	1.02	0.94	0.86			
Sept. 6, a. m.				1.29	1.23	1.17	1.11	1.06	1.01		
1911.											
Sept. 11, a. m.		1.11	0.92	0.78							
Sept. 12, a. m.							0.71	0.60			
Sept. 14, a. m.		1.34	1.29	1.19	1.10	1.02	0.94	0.88	0.83	0.78	0.75
Sept. 20, a. m.		1.06									
Sept. 25, a. m.		1.23	1.01								
Sept. 26, a. m.				0.86							
1912.											
Sept. 1, a. m.			0.77		0.56						
Sept. 2, a. m.	1.20	1.03									
Sept. 6, a. m.		0.94	0.79	0.70	0.66	0.63					
Sept. 17, a. m.		0.95									
Sept. 20, a. m.		1.07	0.92	0.79							
Sept. 21, a. m.		0.97	0.81								
Sept. 28, a. m.		1.13	0.98	0.88	0.78			0.54	0.48		
Sept. 30, a. m.		1.07	1.05	0.94	0.86			0.65	0.59		
Means	1.37	1.18	1.07	1.02	0.94	0.94	0.90	0.76	0.73	[0.78]	[0.75]
1908.											
Sept. 2, p. m.	1.40	1.35									
Sept. 3, p. m.	1.40	1.28	1.16	1.06							
Sept. 9, p. m.	1.48	1.36	1.26	1.16	1.08	1.01					
Sept. 16, p. m.	1.42	1.29	1.18	1.07	1.02	0.97	0.88				
1909.											
Sept. 1, p. m.	1.51	1.13	1.01	0.88	0.76	0.59					
Sept. 2, p. m.		1.28	1.09	0.92	0.78	0.66					
1911.											
Sept. 12, p. m.		0.99	1.06	0.60	0.50						
Sept. 13, p. m.		1.35	1.24	1.14	1.03	0.93	0.83	0.76	0.69	0.62	0.56
Sept. 19, p. m.			1.05								
Sept. 20, p. m.		1.31	1.24	1.15	1.12	1.06	0.96	0.88	0.78		
Sept. 22, p. m.		1.07	0.95	0.84	0.61						
Sept. 25, p. m.		1.15	1.01								
Sept. 26, p. m.		1.16	1.02	1.00	0.92	0.82	0.81	0.77	0.72	0.65	0.59

TABLE 2.—*Solar radiation intensities at Mount Weather, Va., expressed in gram calories per minute per square centimeter of normal surface*—Continued.

Date.	Air mass.										
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
1912.											
Sept. 2, p. m.	......	0.91	......	......	......	......	......	......	......	......	......
Sept. 5, p. m.	......	1.10	0.97	0.85	0.75	0.67	0.60	0.54	0.49	0.44	0.39
Sept. 12, p. m.	......	......	......	......	0.52	0.45	0.36	0.29	......	......	......
Sept. 14, p. m.	1.20	1.10	0.96	0.83	0.73	0.64	0.56	0.51	......	......	......
Sept. 17, p. m.	......	0.99	0.87	0.75	0.64	0.57	0.51	0.45	0.41	0.35	0.31
Sept. 18, p. m.	......	1.08	......	......	......	......	......	......	......	......	......
Sept. 20, p. m.	1.25	1.07	0.94	0.83	0.74	0.66	0.59	0.53	......	......	......
Sept. 27, p. m.	......	......	0.96	0.84	......	......	......	......	......	......	......
Sept. 28, p. m.	......	1.14	0.96	0.82	0.73	0.65	0.58	0.51	0.45	0.40	0.35
Sept. 30, p. m.	......	1.13	0.95	0.80	0.70	0.61	0.53	......	......	......	......
Means	1.38	1.16	1.05	0.91	0.79	0.74	0.66	0.58	0.59	0.49	0.44
1907.											
Oct. 9, a. m.	......	1.45	1.35	1.26	1.18	......	......	......	......	......	......
1908.											
Oct. 2, a. m.	......	......	......	1.04	0.98	......	0.86	......	......	......	......
Oct. 3, a. m.	......	1.43	1.35	1.28	1.21	1.15	1.10	1.06	......	......	......
Oct. 4, a. m.	......	1.27	......	......	......	......	......	......	......	......	......
1909.											
Oct. 22, a. m.	......	1.44	1.36	1.29	1.21	......	......	......	......	......	......
Oct. 26, a. m.	......	1.47	1.34	1.25	1.17	1.09	1.06	......	......	......	......
1911.											
Oct. 4, a. m.	......	1.32	......	......	......	......	......	......	......	......	......
Oct. 5, a. m.	......	......	......	1.12	1.03	0.97	......	......	......	......	......
Oct. 6, a. m.	......	1.23	......	......	......	......	......	......	......	......	......
Oct. 9, a. m.	......	1.29	1.23	1.14	......	......	......	......	......	......	......
Oct. 11, a. m.	......	1.27	......	......	......	......	......	......	......	......	......
Oct. 13, a. m.	......	1.47	1.36	1.26	1.18	1.12	1.07	......	......	......	......
Oct. 18, a. m.	......	1.33	1.20	......	......	......	......	......	......	......	......
Oct. 19, a. m.	......	1.43	1.35	1.27	1.19	1.12	1.05	0.99	......	......	......
Oct. 24, a. m.	......	1.45	1.38	1.30	1.17	1.09	1.04	1.00	......	......	......
Oct. 25, a. m.	......	1.42	1.35	1.29	1.22	1.16	......	......	......	......	......
1912.											
Oct. 1, a. m.	......	1.15	0.99	0.89	0.79	0.70	0.63	0.57	0.51	0.46	......
Oct. 2, a. m.	......	1.14	1.05	......	......	......	......	......	......	......	......
Oct. 3, a. m.	......	1.20	1.08	0.93	0.85	......	......	......	0.56	0.50	......
Oct. 4, a. m.	......	0.99	0.81	0.63	0.56	0.51	0.46	0.42	0.38	0.34	......
Oct. 5, a. m.	......	0.90	0.78	0.64	0.55	0.48	......	......	......	......	......
Oct. 7, a. m.	......	1.13	1.04	0.93	......	......	......	......	......	......	......
Oct. 8, a. m.	......	1.25	1.17	1.05	0.96	0.88	......	......	......	......	......
Oct. 9, a. m.	......	1.17	1.06	0.96	......	......	......	......	......	......	......
Oct. 10, a. m.	......	1.15	1.03	0.92	0.82	......	......	......	......	......	......
Oct. 11, a. m.	......	1.13	1.02	0.89	0.77	......	......	......	......	......	......
Oct. 13, a. m.	......	......	1.12	0.98	0.88	......	......	......	......	......	......
Oct. 15, a. m.	......	1.21	1.11	1.01	0.92	0.83	0.75	......	......	......	......
Oct. 16, a. m.	......	1.34	1.22	1.12	1.01	......	......	......	......	......	......
Oct. 17, a. m.	......	......	......	1.13	0.97	......	......	......	......	......	......
Oct. 26, a. m.	......	1.18	1.06	0.90	0.81	0.73	0.66	......	......	......	......
Oct. 28, a. m.	......	1.20	1.00	0.89	0.80	0.72	0.65	......	......	......	......
Oct. 29, a. m.	......	......	1.15	1.00	0.87	0.75	......	......	......	......	......
Oct. 31, a. m.	......	......	0.88	......	......	......	......	......	......	......	......
Means	......	1.26	1.14	1.05	0.96	0.89	0.85	0.81	0.48	0.43	......
1908.											
Oct. 3, p. m.	......	1.42	1.34	1.26	1.19	1.12	1.06	1.00	......	......	......
1909.											
Oct. 22, p. m.	......	1.43	1.31	1.22	1.13	1.04	......	......	......	......	......
1911.											
Oct. 11, p. m.	......	1.27	1.10	0.96	0.88	0.82	......	......	......	......	......
Oct. 13, p. m.	......	1.47	1.39	1.32	1.25	1.19	1.15	......	......	......	......
Oct. 18, p. m.	......	1.26	......	......	......	......	......	......	......	......	......
Oct. 23, p. m.	......	1.41	1.31	1.23	1.14	1.08	1.02	0.96	......	......	......
Oct. 24, p. m.	......	1.45	1.32	1.20	1.08	1.01	0.95	......	......	......	......
Oct. 25, p. m.	......	......	1.30	1.17	1.05	1.01	0.93	0.86	......	......	......

TABLE 2.—*Solar radiation intensities at Mount Weather, Va., expressed in gram calories per minute per square centimeter of normal surface*—Continued.

Date.	Air mass.										
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
1912.											
Oct. 1, p. m.		1.04	0.84								
Oct. 2, p. m.		1.12	0.93	0.82	0.74	0.67	0.59				
Oct. 3, p. m.		1.18	1.01	0.87	0.74	0.62	0.49				
Oct. 4, p. m.		1.02	0.80	0.62	0.51	0.44	0.39	0.36			
Oct. 7, p. m.		1.06		0.68	0.55						
Oct. 9, p. m.		1.22	1.05	0.90							
Oct. 10, p. m.		1.08	0.94	0.78	0.65						
Oct. 11, p. m.		1.12									
Oct. 12, p. m.		0.95	0.82	0.73	0.62	0.50	0.42	0.36			
Oct. 15, p. m.		1.20	0.83	0.64	0.50	0.37					
Oct. 16, p. m.		1.32	1.21	1.10							
Oct. 21, p. m.			1.24	1.13							
Oct. 26, p. m.			1.04	0.77	0.58	0.38	0.25				
Oct. 28, p. m.		0.96	0.91	0.81	0.75	0.69	0.62	0.56	0.51	0.45	
Oct. 30, p. m.				0.90	0.76	0.66	0.60	0.55	0.51	0.44	
Oct. 31, p. m.				0.75	0.63	0.53					
Means		1.21	1.09	0.95	0.82	0.76	0.71	0.61	[0.51]	[0.44]	
1908.											
Nov. 17, a. m.			1.34	1.26	1.19	1.12	1.05				
Nov. 21, a. m.			1.24	1.24	1.22	1.16	1.11	1.07	1.03		
1909.											
Nov. 12, a. m.			1.22								
1912.											
Nov. 4, a. m.			1.24	1.15	1.05	0.98	0.89				
Nov. 5, a. m.			1.00								
Nov. 8, a. m.			1.17	1.08	0.96	0.84	0.77				
Nov. 11, a. m.			1.04	0.91							
Nov. 14, a. m.			1.21	1.11							
Nov. 21, a. m.			1.19	1.08	1.06	1.03	0.97	0.92	0.87		
Means			1.18	1.12	1.10	1.03	0.96	[1.00]	[0.95]		
1908.											
Nov. 13, p. m.			1.39	1.28							
1912.											
Nov. 5, p. m.			1.08	0.96							
Nov. 8, p. m.					0.98	0.88	0.80	0.74	0.67		
Nov. 11, p. m.				0.88							
Nov. 21, p. m.			1.17	1.08							
Means			1.21	1.05	[0.98]	[0.88]	[0.80]	[0.74]	[0.67]		
1908.											
Dec. 8, a. m.			1.30	1.28	1.21	1.13	1.08	1.03	0.98		
1912.											
Dec. 10, a. m.			1.33	1.25	1.15	1.07	1.00	0.92	0.86	0.82	
Dec. 12, a. m.			1.17	1.00	0.92	0.83	0.76	0.69	0.63		
Dec. 13, a. m.			1.29	1.14	1.04	0.96	0.90	0.84	0.79	0.72	0.68
Dec. 14, a. m.				1.09	1.00	0.91	0.81	0.72	0.65	0.62	0.57
Dec. 15, a. m.			1.27	1.18	1.09	1.01	0.93	0.86	0.80	0.74	0.68
Dec. 16, a. m.				1.17	1.10	1.00	0.96	0.88	0.83	0.78	0.73
Dec. 20, a. m.			1.18	1.14	1.01	0.89	0.80	0.72	0.65	0.57	
Dec. 21, a. m.			1.22	1.11	1.07	0.98	0.89	0.87	0.85	0.83	0.81
Dec. 23, a. m.								0.77	0.72		
Dec. 28, a. m.			1.32	1.25	1.15	1.05	0.98	0.92	0.85	0.79	0.74
Means			1.26	1.16	1.07	0.98	0.91	0.84	0.78	0.73	0.70
1908.											
Dec. 2, p. m.			1.31	1.22	1.14	1.07	1.01	0.96	0.91		
Dec. 8, p. m.				1.19	1.12	1.05	0.98	0.92	0.87		

TABLE 2.—*Solar radiation intensities at Mount Weather, Va., expressed in gran colories[8] per minute per square centimeter of normal surface*—Continued.

Date.	Air mass.										
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
1912.											
Dec. 3, p. m	......	......	......	......	......	......	0.72	0.65	0.59	0.56	0.52
Dec. 9, p. m	......	......	1.31	1.20	1.08	1.01	0.94	0.86	0.79	0.73	0.68
Dec. 12, p. m	......	......	......	1.12	1.03	0.92	0.87	0.81	0.74	0.68	......
Dec. 13, p. m	......	......	......	1.17	......	......	......	......	......	......	......
Dec. 15, p. m	......	......	......	1.06	0.96	0.89	0.81	0.73	0.65	0.59	0.54
Dec. 20, p. m	......	......	......	1.15	1.02	0.94	0.85	0.78	0.72	0.66	......
Dec. 21, p. m	......	......	......	1.09	0.98	0.86	0.73	0.71	0.68	0.63	......
Dec. 28, p. m	......	......	......	1.23	1.14	1.06	0.98	0.91	0.85	......	......
Means	......	......	[1.31]	1.16	1.06	0.98	0.88	0.81	0.76	0.64	0.58

TABLE 3.—*Monthly mean percentage of polarization of skylight at Mount Weather, Va., measured at the point of maximum polarization, with the sun at zenith distance 60°.*

Month.	Year.				$\frac{1908+1909+1911}{3}-1912$
	1908	1909	1911	1912	
May	61	64	48	53	+ 5
June	59	......	61	48	+12
July	62	......	55	39	+19
August	61	56	59	32	+27
September	65	64	60	40	+23
October	66	70	69	44	+24
November	......	......	......	47	..
December	68	......	......	52	+16

TABLE 4.—*Comparison of sky polarization and solar-radiation data for Mount Weather, Va., for the months of May to December, inclusive, 1911 and 1912.*

Period.	Percentage of polarization of skylight.				Maximum radiation intensities.					
	1911		1912		1911			1912		
	Max.	Min.	Max.	Min.	Air mass.			Air mass.		
					1.0	1.5	2.0	1.0	1.5	2.0
May	66	36	72	34	1.32	1.10	1.06	1.42	1.27	1.19
June 1-9	......	......	67	54	1.36	1.22	1.12	1.42	1.36	1.24
June 10-30	72	47	64	14	1.48	1.37	1.27	1.25	1.19	1.05
July	74	31	47	13	1.47	1.37	1.31	1.24	1.05	0.96
August	76	44	41	23	1.39	1.33	1.23	1.08	1.02	0.86
September	75	49	59	35	......	1.35	1.29	......	1.14	1.05
October	78	59	51	32	......	1.47	1.39	......	1.34	1.24
November	*73	*53	57	43	......	......	*1.39	......	......	1.24
December	*71	*68	61	39	......	......	......	......	......	1.33

* Data for the year 1908.

TABLE 5.—*Mean distance of Arago's neutral point from the antisolar point.*

Place of observation	Washington.	Madison.	Phoenix.	Flagstaff.	Santa Fe.		Lake Peak.	Mount Weather.		
Period of observation	Jan. to May, 1910.	July to Aug., 1910.	Oct., 1910.	Sept., 1910.	Sept., 1910.	Oct., to Nov., 1912.	Oct. 29, 1912.	May, 1911, to June, 1912.	July 27, 1912.	Sept., 1912, to Feb., 1913.
Altitude of sun:										
+6.5	20.2	......	19.7	......	18.2	......	26.5	......	......	......
+6.0	20.5	......	19.5	......	18.2	25.5	25.9	21.0	......	......
+5.5	20.2	......	19.3	......	18.4	25.3	26.5	21.6	......	......
+5.0	20.2	23.6	19.4	......	18.3	25.5	26.6	21.4	......	26.4
+4.5	21.0	22.7	19.5	......	......	25.0	27.3	21.4	......	26.5
+4.0	20.8	22.0	19.6	......	......	25.0	26.4	20.8	......	26.2
+3.5	20.3	22.0	19.4	17.3	......	25.1	26.2	20.1	......	25.8
+3.0	20.2	22.0	19.2	......	17.6	24.7	26.0	20.0	......	26.1
+2.5	20.4	21.4	19.5	19.1	18.0	24.7	25.5	19.8	......	25.8
+2.0	20.3	21.0	......	18.4	......	24.4	25.1	19.9	......	25.0
+1.5	19.8	20.6	18.6	17.4	......	24.0	23.9	19.9	23.0	24.4
+1.0	19.4	20.5	18.7	......	......	23.1	23.1	19.7	23.0	23.6
+0.5	19.3	20.3	18.9	......	16.6	21.6	21.4	19.6	21.1	23.0
±0.0	19.0	19.6	......	17.5	......	19.8	18.6	19.1	19.9	22.2
−0.5	18.6	19.1	18.7	......	17.1	18.4	15.8	19.1	17.8	19.9
−1.0	18.5	......	19.1	......	17.0	17.5	14.6	19.1	16.1	19.6
−1.5	18.3	......	......	17.2	17.0	17.6	14.4	18.3	15.8	19.6
−2.0	18.3	......	......	16.7	17.2	18.2	13.9	17.6	15.4	18.6
−2.5	18.2	......	......	......	......	18.4	14.1	17.6	15.0	18.7
−3.0	......	......	......	19.3	18.0	17.9	14.0	18.7	14.9	18.6
−3.5	......	......	20.7	19.6	......	18.3	15.0	18.8	15.1	18.6
−4.0	......	......	......	......	......	18.4	15.4	......	16.1	18.9
−4.5	......	......	......	......	......	19.5	16.7	......	16.8	19.6
−5.0	......	......	......	......	......	20.6	18.6	......	19.4	20.9
−5.5	......	......	......	23.5	......	21.3	......	......	......	......
−6.0	......	......	27.0	24.8	......	......	......	......	......	......
−6.5	......	......	28.4	26.2	......	......	......	......	......	......
Number of series of observations	17	3	8	7	8	10	1	27	1	10

TABLE 6.—*Mean distance of Babinet's neutral point from the sun.*

Place of observation	Madison.	Phoenix.	Flagstaff.	Santa Fe.		Lake Peak.	Mount Weather.		
Period of observation	July, 1910.	Oct., 1910.	Sept., 1910.	Sept., 1910.	Oct. to Nov., 1912.	Oct. 29, 1912.	May to June, 1911.	Aug., 1911, to June 8, 1912.	June 10, 1912, to Feb., 1913.
Altitude of sun:									
+2.0	......	......	......	......	......	......	......	......	......
+1.5	......	17.4	......	14.8	......	......	......	......	......
+1.0	......	17.3	15.8	......	......	......	......	......	......
+0.5	......	17.4	16.2	......	19.2	......	18.7	17.1	25.0
±0.0	......	17.7	......	......	18.2	......	18.1	16.7	22.6
−0.5	......	18.0	15.8	15.3	17.4	......	17.8	16.8	21.0
−1.0	......	17.9	......	......	16.8	......	18.5	17.4	21.0
−1.5	18.0	17.7	......	15.6	16.7	12.2	18.8	17.0	20.2
−2.0	17.7	17.6	15.8	......	17.2	13.8	18.8	16.9	19.8
−2.5	17.2	16.8	......	......	17.5	13.4	18.7	17.0	19.1
−3.0	17.3	16.7	......	14.4	17.8	14.0	18.6	16.9	19.3
−3.5	16.6	16.5	14.2	......	17.3	15.3	18.6	17.4	18.4
−4.0	16.0	17.0	15.0	14.0	16.4	16.6	......	17.5	18.0
−4.5	15.6	17.1	15.4	......	16.8	18.0	......	17.7	17.3
−5.0	16.0	17.3	15.5	......	16.4	18.6	......	17.6	17.1
−5.5	......	18.0	......	......	......	......	......	17.8	......
−6.0	......	17.7	......	......	......	......	......	17.7	......
Number of series of observations	2	8	7	4	8	1	3	15	9

XV. THE HAZE OF THE UPPER ATMOSPHERE.

By R. O. E. Davis, Bureau of Soils.

[Dated March, 1913.]

The haze which often exists in the upper atmosphere is of interest to aerology in that it is indicative of the direction and the velocity of air movement in that region. The density of the haze affects the amount of light and heat that reach the surface of the earth, and no doubt the character of this haze produces other effects which are not understood.

The movement of material by the wind has been comprehensively treated by Free in a publication of the Bureau of Soils,[1] in which a complete bibliography of the subject has been included by Stuntz and Free. The origin of the material composing the haze of the atmosphere is, of course, largely terrestrial, and composed of fine particles picked up from the earth's surface and borne aloft. But aside from the evidence of particles of solid material in the air, as observed in the haze, their presence in every portion of the air is made manifest in the motes of dust illuminated by a beam of light passing through a darker space. This dust is composed of organic material, smoke, mineral matter from the soil, and small amounts of material ejected from volcanoes. Much of the material does not remain long in suspension and ordinarily is not transported far from its origin. In quiet air no particles are permanently in suspension; they slowly settle and when a wind rises new material is taken up in their place. Thus dust is always present in the atmosphere, and the individual particles are constantly changing. Very fine dust is normally present in the air and thus may be distinguished from the soil material which is often moved from place to place.

While the great bulk of the atmospheric dust is of terrestrial origin, some of it is derived from extra-terrestrial sources. The meteors entering the earth's atmosphere each day are estimated as equaling fully 100 tons. Very little of this material reaches the earth's

[1] Bul. No. 68, Bureau of Soils, Dept. of Agric. (1911): Movement of Soil Material by the Wind, by E. E. Free.

surface as meteorites; a rapid disintegration ensues on passing through the atmosphere and the result is a transformation into dust particles which may remain in suspension a long time.

The minute particles of metallic iron often observed [1] probably have a meteoric origin. Cobalt and nickel are found in small amounts in them.[2] The presence of nickel and cobalt does not prove the origin of the metallic spherules to be cosmic as Hartley and Ramage [3] have found them in ordinary coal smoke. However, the fact that such spherules are found in ancient rocks points to a cosmic origin, so that the metallic particles are probably in part of terrestrial and partly of extra-terrestrial origin.

In the eruption of volcanoes, not only are gases and liquid lava ejected but great quantities of solid material are thrown out, varying in size from bowlders to fine dust or ashes. Much of it is so fine that it is carried long distances by the wind. This quantity is larger than is generally supposed. It has been estimated by Shaler [4] that at least 300 cubic miles of fine dust has been discharged by the Javanese and Malayan volcanoes since 1770, and probably an even greater quantity has been discharged by other volcanoes during the same time.

The character [5] of the volcanic dust is largely that of glass or vitreous material. The quantity produced by any eruption is largely dependent on the violence of the explosion. The greater the quantity of steam confined, the more violent will the explosion be and the amount of dust will be correspondingly greater. All eruptions produce some dust.

Volcanic dust is easily lifted and transported by the wind; the rising currents of air and steam over the volcanoes often carry it to great heights. From these great heights much of the dust may be transported by atmospheric currents to great distances before being deposited. Scandinavia, Great Britian, and Holland have experienced a fall of volcanic dust from Iceland.[6] Records exist of volcanic

[1] Monatsb. K. Preuss. Akad. Wiss., Berlin (*1858*) 1–41; Ann. Phys. Chem. (Poggendorff) *106*, 476–490 (1859); Compt. Rend. *80*, 58–61 (1875); *81*, 576–579 (1875); *83*, 75–78 (1876).

[2] Compt. rend. *83*, 75–76 (1876); Tissandier Les Poussières de l'air, p. 49.

[3] Proc. Roy. Soc. *68*, 97–109 (1901); Proc. Roy. Dublin Soc. (N. S.) *9*, 547–555 (1901).

[4] Ann. Rpt. U. S. Geol. Survey, *12*, 1; 240–241 (1891).

[5] Zirkel—Neues Jahrb. Min. (1872) 24; Murray and Renard, Proc. Roy. Soc. Edinburg, *12*; 477–488 (1883–84); Beijerinck—Nature *29*, 308–9 (1884); Diller—ibid *30*, 91–3 (1884); Science *3*, 651–4 (1884); Judd—Roy. Soc. Rept. on Krakatoa, plates 3+4 (1888).

[6] Zirkel—Neues Jahrb. Min. (1875) p. 399; Daubrée—Compt. Rend. *80*, 994, 1059 (1875); N. A. E. Nordenskiöld—Geol. Mag. (2) *3*, 292–97 (1876); Met. Zs. *11*, 201–206 (1894); Geikie—Textbook of Geology, 4th ed., vol. *1*, p. 295 (1903); Von Rath—Monatsb. K. Preuss. Akad. Wiss., Berlin (1875), p. 282–86.

dust transport of 1,000 miles;[1] distances from 200 to 500 miles [2] being quite common. This all refers to the falls of dust in such quantities that it could be collected and examined. It is also known from the optical effects produced, that small amounts of dust are carried to very much greater distances; in a few cases the effects have been exhibited in every portion of the earth.

In addition to the inorganic substances composing the dust of the atmosphere, organic substances are present to a considerable extent in the form of plant fiber, pollen, etc. Because of their low specific gravity and irregular shape, these are easily transported by the wind. Among 50 samples of dust examined by Macagno and Tacchini,[3] 25 contained more organic than inorganic particles, 18 were predominantly organic and in 7 there were approximately equal quantities of organic and inorganic material. The presence of organic substances in dust has been frequently noted.[4] Ordinary dust has been declared [5] to contain 25 to 34 per cent of combustible organic matter. Live spores and seeds of plants are always present in the dust of the atmosphere.[6] The presence of these substances in the haze of the atmosphere depends, of course, on the velocity of the air currents and the shape and size of the particles as well as their specific gravity.

As has been stated, all of this material finds its way into the atmosphere by some disturbance such as dust storms, volcanic eruptions, or the fall of meteors. After the disturbance has passed the suspended particles begin to settle, the rate depending upon the size and shape of the particles. Nevertheless, there are always present in the atmosphere particles of solid material, and some of these remain in suspension practically indefinitely. The minute particles of solid as well as liquid (water) meet with so much resistance from the air that their rate of subsidence is extremely slow. It has

[1] Elie de Beaumont—Leçons de géologie pratique, vol. 1, p. 188 (1847); Richardson—Roy. Soc. Rept. on Krakatoa, pp. 199–217 (1888); Russell—Ibid, pp. 384–405; Judd—Nature *29*, 152, 595 (1883–84).

[2] Dust from Colima in Mexico; Osdonez—Rev. Soc. cient. Antonio Alzate *20*, 99–104 (1903); Kerber—Verh. Ges. Erdk. Berlin *9*, 237–246 (1882); Sperry—Amer. Jour. Sci. (4) *15*, 487–488 (1903).

[3] Ann. meteor. ital. (2) *1*, 73 (1879).

[4] Sementini—Giorn. fis. chim. stor. nat. (2) *1*, 28–32 (1818); Reissek—Ber. Mitt. Freunden Naturw. *4*, 153 (1848); Arago—Oeuvres complètes *12*, 468–470 (1859); Bouis—Compt. rend. *56*, 972 (1863); Silvestri—Atti. Accad. Gioenia Catania (3) *12*, 140–141 (1878); von Lasaulx—Tschermak's min. Mitt. *3*, 526, 529 (1880); von John—Verh. Geol. Reichsanst. (1896), 259; Passerini—Atti. R. Accad. econ.-agr. Georg. Florence (4) *24*, 139, 142, 152 (1901); Becke—Anz. Kaiserl. Akad. Wiss., Vienna, *38*, 108 (1901); Chauveau—Ann. Soc. météor. France *51*, 75 (1903); Früh.—Met. Zs. *20*, 174 (1903).

[5] Tissandier—Les Poussières de l'air, p. 11, 16 (1877).

[6] De Candolle—Géographie botanique raisonnée, vol. *2*, p. 613–615 (1855); Kerner—Zts. deut. Alpenver *2*, 144–172 (1871); Hildebrand—Die Verbreitungsmittel der Pflanzen (1873); E. J. Hill—Amer. Nat. *17*, 812–818 (1883).

been calculated [1] that a sphere of iron 0.018 millimeter in diameter will fall at a maximum rate of 1.69 meters per second. The size of the metallic particles found in the atmosphere is almost always smaller [2] than this, so that they will settle more slowly. Nor is it difficult to conceive of practically indefinite suspension for some of these particles, since the currents and eddies of air will be constantly moving them from one position to another. Material of a vitreous, mineral, or organic character can be held in suspension even more easily, so that with the ease of movement and the constant shifting and changing of air currents the dust of the atmosphere becomes practically the same the world over.

Of the dust that finds its way to the ground the greater part is carried down by rain or snow. Not only does precipitation wash down much of the dust, but the particles themselves serve as nuclei for the formation of rain drops.[3]

During daylight, suspension of dust may be assisted by the absorption of heat by the dust particles themselves.[4] Radiant heat from both sun and earth is absorbed more rapidly by the particles of dust than by the adjacent air of the surrounding atmosphere. These particles in turn become sources of radiant energy and thus dusty air in the sunshine is more highly heated than that which is free from dust. Air currents are thus induced and a thorough mixing of the atmosphere may ensue. Aitken observed that the concentration of solar rays by means of a large lens upon the particles of dust in the air did not affect them, while larger objects were ignited and burnt up. The motes probably lose their heat very rapidly to the surrounding air.

The amount of dust in the air is very variable. The presence of much dust in dry seasons gives rise to "dry fogs." In desert regions and thickly settled communities, or in regions near these, the amount of dust in suspension is greatest. It is least in winds coming from oceans or vegetal-covered regions. The amounts brought down by rain have been estimated as from 25 to 172 milligrams per liter, and by snow from 16 to 75 milligrams per liter.[5] As the amounts of rain

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[1] Flögel—Zts. Met. *16*, 326 (1881); Plumandon. Poussières atmospheriques, p. 33 (1897).

[2] Tissandier found them from 0.01 to 0.001 millimeter in diameter (Compt. Rend. *78*, 823 (1874); *80*, 59 (1875).

[3] Aitken—Trans. Roy. Soc. Edinburgh *30*, 337-368 (1883); Abst. Proc. Roy. Soc. Edinburgh *11*, 14-18, 122-126 (1882); Ibid., *12*, 448, 467 (1883-4); Ibid, *14*, 121 (1886-7); Ibid., *16*, 134-172 (1888-9); Ibid., *18*, 259 (1890-91); Ibid., *36*, 313 (1891); Ibid., *39*, 15, (1898); Bull. 11, Weather Bureau, U. S. Dept. Agric. (1893); Wilson—Nature *68*, 548-550 (1903).

[4] Mill and Lempfert—Quart. Jour. Roy. Meteor. Soc. *30*, 71 (1904); Serell—Nature *30*, 53-54 (1884).

[5] Tissandier—Les Poussières de l'air, p. 16 (1877); Compt. Rend. *80*, 59 (1875); *81*, 576 (1875). A. Schuster—Rept. Brit. Assoc. (1883), p. 126.

and snow which fell are not given, the figures are of little value. In fact the amount of dust may vary between very wide limits, depending on the operation of various factors causing its production and tending to keep it in suspension.

The blue color of the sky is partly due to the dispersion [1] of light by the dust particles, and the red color of sunsets has a similar cause. At times the sunsets are unusually brilliant from the presence of large amounts of dust,[2] as in deserts or following volcanic eruptions. Occasionally the sun appears red in the middle of the day, due to the large amounts of dust particles in suspension, and a green and blue sun have been reported [3] due to atmospheric dust.

The presence of this dust in the atmosphere diminishes the intensity of heat and light rays as they pass through it. This is most noticeable when a "dry fog" or "dust haze" is produced by the accumulation of much dust in the atmosphere. Following forest fires or volcanic eruptions [4] this hazy condition may persist for days or weeks. Our autumn atmosphere is more or less hazy, as the conditions [5] are such as to cause an unusual accumulation of dust in the lower layers of the atmosphere. This hazy condition is common in all desert and steppe regions.[6] A dry fog in 1783 covered all Europe and persisted for months. It was believed to be due to a volcanic eruption in Iceland during May and June.[7] Similar conditions followed various eruptions, among the later ones being Pelée in 1902 [8] and Vesuvius in 1906.[9] Often the haze may be invisible and yet a great reduction in the heat intensity of the sun's rays may be observed.[10]

[1] Tyndall—Phil. Mag. (4), *37*, 384–394 (1869); *38*, 156–158 (1869); Rayleigh—Ibid. (4) *41*, 107–120, 274–279, 447–454 (1871); (5) *12*, 81–101 (1881); *47*, 375–384 (1899). E. L. Nichols—Phys. Rev. *26*, 497–511 (1908); Pernter—Meteorologische Optik, pp. 560–654 (1910); N. E. Dorsey—Mon. Weath. Rev. *28*, 382–389 (1900).

[2] Kiessling—Sitzungsb. Ges. ges. Naturw. Marburg. (1904) 9–11; F. A. R. Russell—Roy. Soc. Rept. on Krakatoa, pp. 151–199 (1888); Nature *66*, 77, 101–102, 199, 222–223, 294–296, 370, 390 (1902); Gruner—Mitth. Naturf. Ges. Bern (1903) 1–5.

[3] Archibald—Roy. Soc. Rept. on Krakatoa, pp. 199–217 (1888); Russell—Ibid., p. 384.

[4] Forel—Compt. Rend. *137*, 380–382 (1903); *138*, 688–690 (1904); *140*, 694–696 (1905); H. H. Clayton—Sci. (N. S.) *17*, 150–152 (1903).

[5] C. Abbe—Mon. Weath. Rev. *29*, 374 (1901).

[6] Schmid—Lehrbuch der Meteorologie, pp. 793–794 (1860); Hornemann—Voyage dans l'Afrique Septentrionale, vol. 1, p. 111 (1803); Tietze—Jahrb. Geol. Reichanst. *27*, 347–348 (1877); Hellmann—Monatsb. K. Preuss. Akad. Wiss. Berlin. (1878), p. 397; Brewer—Bul. Amer. Geog. Soc. *21*, 212 (1889); Russell—U. S. Geol. Sur. Bull. *199*, 18 (1902).

[7] Brugmans—Verhandeling over een zwavelagtigen Nevel (1783); Bertholon—Lit. Mag. and Brit. Rev. *2*, 97–103 (1789); Martins—Proc. Verb. Soc. Philom. Paris (1851), pp. 5–11; C. Abbe—Proc. Am. Phil. Soc., XLV, 1906, p. 127.

[8] Gockel—Met. Zts. *20*, 328 (1903); H. E. Hobbs et al.—Mon. Weath. Rev. *30*, 487–488 (1902).

[9] Meunier—Compt. Rend. *142*, 938 (1906).

[10] Hobbs.—loc. cit.

A long range weather forecast by Benjamin Franklin was based on the phenomena of 1783.[1]

In general the atmospheric dust appears to vary in quantity with the disturbing factors producing it, and the atmospheric conditions favorable to its continuance. It is composed of organic and inorganic material, and varies somewhat in composition with the locality. Optical effects of the atmosphere are due to its presence and it is closely connected with the formation and precipitation of rain. The intensity of heat rays reaching the earth's surface is influenced by its presence. Its composition often indicates the direction and source of the wind. Thus its importance meteorologically is evident.

[1] Cleveland Abbe—Benjamin Franklin as Meteorologist, Proc. Am. Phil. Soc., XLV, 1906, pp. 117–128.

(XVI) DYNAMIC METEOROLOGY.[1]

By H. BATEMAN.

[Dated Baltimore, Feb. 24, 1913.]

In order that a branch of physics may become really attractive to mathematicians it is necessary in the first place that information with regard to the fundamental problems awaiting solution should be readily accessible; secondly, that some of the pioneer mathematical work in the subject should possess those qualities of precision, elegance, generality, and simplicity which appeal to a mathematician's sense of beauty.

As regards the second requirement, the science of meteorology is somewhat handicapped on account of the complexity of the phenomena and the difficulties in the way of a comprehensive mathematical treatment. It will be seen, however, from the article we are reviewing that by means of simplyfing assumptions, results of some elegance have been obtained. Mathematicians are not justified in saying that the time is not ripe for the solution of the fundamental problems because the invention of satisfactory and self-recording instruments has led to so many improvements in the methods of observation, that the experimental data are now attaining the necessary exactness and are of the type which the mathematician requires.

Moreover, there is no lack of problems awaiting solution. In addition to the classical problems concerning the general circulation of the atmosphere, the diurnal and semidiurnal oscillations of the barometer, the motion of the air in cyclones, etc., a number of new questions have been raised by recent discoveries such as the isothermal region in the upper atmosphere [2] and the nature of the electric charges on different kinds of rain.[3]

Mathematicians who wish to become rapidly acquainted with the problems of meteorology will find that the road has been made com-

[1] Dynamische Meteorologie von Felix M. Exner und W. Trabert. Encyklopädie der Mathematischen Wissenschaften. Band VI, 1 B. Heft 3, pp. 179–234. Leipzig. B. G. Teubner, 1912.

[2] L. Teisserenc de Bort. Comptes Rendus. t. 134 (1902), p. 987. R. Assmann. Berlin. Ber. (1902). p. 495.

[3] Simpson. Phil. Trans. London. Ser. A. Vol. 209. p. 379. (1909.) McClelland and Nolan. Proc. Roy. Irish Academy. Vols. 29–30. Ser. A. (1912.)

paratively easy for them. Many important mathematical memoirs on the subject have been collected together and translated by Prof. Cleveland Abbe,[1] whose recent article in the Encyclopedia Britannica gives a good bird's-eye view of the whole subject. In addition to these we have the recent report by Messrs. Gold and Harwood on the present state of our knowledge of the upper atmosphere [2] and the article by Exner and Trabert now under review.

Trabert's account of the fundamental ideas of meteorology commences with a brief description of the simplest instruments. He indicates the advantages of using Assmann's aspiration psychrometer, and points out the defects of the hair hygrometer. He next explains the application of statistical methods to the deviations from mean values and justifies it in some cases by means of examples. In calculating the mean value of the annual temperature from a finite number n of records, the probable error is given in terms of the mean deviation v by Fechner's formula

$$\frac{1.1955}{\sqrt{2n-1}}v$$

and is less than 1° only if n is quite large (about 800).

To bring this part of the article up to date, some mention ought to be made of Prof. Karl Pearson's method of correlation which has been used recently in the discussion of the results of balloon ascents by W. H. Dines,[3] and the periodogram method of Prof. Schuster.[4]

Attention is next drawn to the value of charts showing isothermal or isobaric lines. Expressions for the distribution of pressure or temperature over the earth's surface in series of spherical harmonics could hardly have a greater value. Expansions in terms of trigonometrical functions of the time, however, give important information on the variations of the barometer; in this case the first few terms suffice and their coefficients are seen to vary with the latitude.

Various forms of the barometric altitude formula are given and it is shown that a surface of given constant pressure rises as the temperature increases.

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[1] Smithsonian Miscellaneous Collections. 1891 and 1910.

[2] British Association Reports. Winnipeg. (1909.) See also W. N. Shaw and W. H. Dines. The Free Atmosphere in the Region of the British Isles. London. H. M. Stationery Office (1909). Reviewed in Nature. Apr. 21, 1910.

[3] W.H. Dines and W. N. Shaw. The Free Atmosphere in the Region of the British Isles. Meteorological Office. Geophysical Memoirs. No. 2. pp. 13-50. (1912.)

[4] An application to the analysis of rainfall records is mentioned by Prof. H. H. Turner. British Association Reports. Portsmouth. (1911.) p. 314.

The constitution of the atmosphere is next discussed. Hann's theory of the diffusion of the separate constituents in accordance with Dalton's law leads to the conclusion that at a height of 100 kilometers the atmosphere consists almost wholly of hydrogen.[1]

According to recent researches, a sudden change takes place in the constitution of the atmosphere at a height of about 70 kilometers; beyond this the upper regions consist of hydrogen and an unknown very light gas (geocoronium), the proportion of which increases gradually with the height.[2] Some evidence of a total reflection of sound waves at the lower boundary of the hydrogen atmosphere was obtained by Von dem Borne after the dynamite explosion on the Jungfrau railway. The total reflection of sound waves at a surface of discontinuity in the atmosphere should provide an interesting problem for mathematicians; it is possible that some modification of the analysis given recently by Prof. Lamb[3] and Mr. J. H. C. Searle[4] for the propagation of waves in an atmosphere of varying density may lead to an accurate solution.

Trabert points out that it is not legitimate to calculate the distribution of water vapor in the atmosphere by using Dalton's law, for condensation and precipitation counteract the upward flow produced by diffusion and convection. In fact in the lower regions the atmosphere is never in equilibrium as far as its constitution is concerned. The essential difference between water vapor and the other gases of the atmosphere depends on the changes of state to which it is liable and these are next discussed from the thermodynamical point of view. Starting from the energy equation[5]

$$\delta Q = c_v dT + Apdv = c_p dT - Avdp$$

and the barometric altitude formula $dp = -\rho dh = -\frac{1}{v}dh$, we have for an adiabatic change without condensation

$$c_p dT = -Adh \text{ or } \frac{dT}{dh} = -0.01.$$

[1] The calculations have been recently repeated by Humphreys with better assumptions with regard to the distribution of temperature in the upper regions. Bull. of the Mount Weather Observatory II, 2.

[2] A. Wegener. Thermodynamik der Atmosphere, Leipzig, (1911), p. 43.

[3] Proc. London Math. Soc. Ser. 2, vol. 7, p. 122 (1909).

[4] Quarterly Journal of Mathematics (1907). See also J. W. Nicholson, Proc. Roy. Soc. London, Ser. A, vol. 81. (1908.) Lord Rayleigh, Ibid. 1912.

[5] δQ = gain of heat energy, A = heat equivalent of work, p = pressure, T = absolute temperature, c_p, c_v = specific heats at constant pressure and constant volume, respectively, v = specific volume, ρ = weight of air per unit volume $= \frac{1}{v}$, h = altitude, $pv = RT$, $c_p - c_v = AR$.

This law, which is sometimes associated with the name of Ivory, is frequently used in mathematical investigations. When condensation takes place so that a mass dq of water vapor gives up latent heat ldq the adiabatic equation is

$$o = c_p dT - Adh + ldq$$

and this leads to a more complicated formula for the temperature gradient. A reference might have been given here to Hann's tables and to some memoir where the details of the work are carried out.[1] The graphical methods which Bezold has used for the study of pseudo-adiabatic processes are sketched very briefly and some mention is made of processes for which $dQ = \pm o$, and to the diagrams of Hertz and Neuhoff.

The experimental data connected with radiation and the distribution of temperature over the earth's surface are discussed in sections 7–8, and a short account is given of the results derived from balloon ascents. Radiation phenomena are now regarded with additional interest in view of a satisfactory explanation of the unexpected temperature conditions of the stratosphere.[2]

The mathematical theory of the deviating force due to the earth's rotation is next given. It is shown that this deviating force is perpendicular to the wind velocity and directed toward the right. Since, moreover, the friction is in the opposite direction to the wind velocity it follows that the force due to the pressure gradient must be directed to the left, making an acute angle with the direction of motion. The lower pressure is thus on the left. (Buys Ballot's law.)

Exner's article on the dynamics of the atmosphere commences with the general hydrodynamical equations of motion in polar coordinates. If ϕ denotes the geographical latitude, λ the longitude (increasing toward the west) and r the distance from the center of the earth, these equations are

$$\ddot{r} - r\dot{\lambda}(\dot{\lambda} - 2\omega)\cos^2\phi - r\dot{\phi}^2 = -g - \frac{1}{\rho}\frac{\partial p}{\partial r} - F_r \qquad (1)$$

$$r\ddot{\lambda}\cos\phi + 2\dot{r}(\dot{\lambda} - \omega)\cos\phi - 2r\dot{\phi}(\dot{\lambda} - \omega)\sin\phi = -\frac{1}{\rho r\cos\phi}\frac{\partial p}{\partial\lambda} - F_\lambda \qquad (2).$$

$$r\ddot{\phi} + 2\dot{r}\dot{\phi} + r\dot{\lambda}(\dot{\lambda} - 2\omega)\sin\phi\cos\phi = -\frac{1}{\rho r}\frac{\partial p}{\partial\phi} - F_\phi \qquad (3)$$

[1] References are given by Wegener, l. c., p. 116.

[2] See the mathematical work of E. Gold, Proc. Roy. Soc., London, Ser. A, vol. 82, p. 43; British Association Reports, Sheffield, 1910; W. J. Humphreys, Astrophys. Journal, vol. (29) (1909), p. 14; and British Association Reports, Portsmouth (1911). F. H. Bigelow, Am. Jour. Sci., vol. 35, March, 1913, p. 254.

The axes of reference are supposed to be rigidly connected with the earth which is rotating with angular velocity ω from W to E. Small quantities such as squares of the component velocities are usually neglected so as to simplify the equations and enable them to be easily solved.

It should be remarked that $\ddot{r}=\frac{d}{dt}(\dot{r})$ where $\frac{d}{dt}$ denotes the hydrodynamical operator

$$\frac{d}{dt}=\frac{\partial}{\partial t}+\dot{r}\frac{\partial}{\partial r}+\dot{\phi}\frac{\partial}{\partial \phi}+\dot{\lambda}\frac{\partial}{\partial \lambda}.$$

In addition to the above there is the equation of continuity

$$\frac{d\rho}{dt}+\rho\left(\frac{\partial \dot{r}}{\partial r}+\frac{2\dot{r}}{r}+\frac{\partial \dot{\phi}}{\partial \phi}-\dot{\phi}\cdot\tan\phi+\frac{\partial \dot{\lambda}}{\partial \lambda}\right)=0 \tag{4}$$

and the gas equation $p=\rho RT$ for moist air.[1] If the motion is assumed to be symmetrical with regard to the earth's axis and friction is neglected, we may put $\frac{\partial p}{\partial \lambda}=0$, $F_\lambda=0$ and the second equation gives

$$\frac{r^2\cos^2\phi}{2}(\dot{\lambda}-\omega)=\text{const.} \tag{5}$$

For large motions in latitude this equation gives too high velocities.

When the parallels of latitude are considered, after Helmholtz, as parallel closed rings of air, and friction is neglected, then equation (3) indicates that for a calm ($\dot{\lambda}=0$) we have $\frac{\partial p}{\partial \phi}=0$. The value of $\frac{\partial^2 p}{\partial \phi^2}$ shows that p is a maximum, and so the belts of high pressure (the horse latitudes) are more or less calm. Helmholtz's theory also gives the proper direction for the prevailing winds on the two sides of these belts. Ferrel's calculation of the position of these belts is then given.

It is next shown that by putting $\ddot{\phi}=\dot{r}=0$, i. e , neglecting the vertical motion and the meridional acceleration and writing $v=\dot{\lambda}r\cos\phi$ equation (3) becomes

$$\frac{v^2}{r}\tan\phi-2\omega v\sin\phi=-\frac{1}{\rho r}\frac{\partial p}{\partial \phi} \tag{6}$$

[1] The equation of energy may be added to these, but when conduction, viscosity, and other small terms are neglected it reduces to the ordinary thermodynamical equation. Cf. F. R. Sharpe. American Journal of Mathematics. (1910.)

Ferrel uses this equation to account for the low pressure at the south pole.

The scheme of the general circulation is now discussed and the question is raised whether layers of air at different temperatures and with different velocities can be in equilibrium. Helmholtz shows that this is possible if the potential temperature [1] of the higher layer is greater than that of the lower; for stability the potential temperature must increase with the height.

The source of energy of atmospheric disturbances is attributed to the decrease of potential energy which takes place when cool air sinks to take the place of the warm air underneath. Two examples are given to show that this theory of Margules gives a wind velocity of the right order of magnitude.

For horizontal motion we have the simplified equations of Guldberg and Mohn

$$\begin{aligned} \frac{du}{dt} + 2\omega v \sin\phi + ku &= -\frac{1}{\rho}\frac{\partial p}{\partial n} \\ \frac{dv}{dt} - 2\omega u \sin\phi + kv &= -\frac{1}{\rho}\frac{\partial p}{\partial y} \end{aligned} \tag{7}$$

where (ku, kv) are the components of a frictional force opposing the velocity. If we resolve along the normal we obtain [2]

$$\frac{V^2}{r} \pm 2\omega V \sin\phi = \frac{1}{\rho}\frac{\partial p}{\partial n} \tag{8}$$

where V denotes the velocity of the air, r the radius of curvature of the path, and $\frac{\partial}{\partial n}$ a differentiation along the outward drawn normal. Gold writes this equation in the form

$$(\omega r \sin\phi \pm V)^2 = \frac{r}{\rho}\frac{\partial p}{\partial n} + (\omega r \sin\phi)^2 \tag{9}$$

and so obtains upper limits for $\frac{\partial p}{\partial n}$ and V in anticyclonic regions.[3] $\left(\frac{\partial p}{\partial n}\right.$ negative.)

[1] This is the temperature which a mass of air would have if brought adiabatically to some standard pressure.

[2] A somewhat similar equation may be derived from Ferrel's equations I, II, III by resolving along the principal normal to the path.

[3] Proc. Roy. Soc., vol. 80 (1908), Barometric Gradient and Wind Force, London, Wyman & Sons. A similar transformation may be applied to Ferrel's equation (6). It gives $\frac{1}{\rho}\frac{\partial p}{\partial\phi} < \omega^2 r^2 \sin 2\phi$.

The equations for curved paths in polar coordinates are next given, and it is shown that when the isobars are concentric circles

$$\frac{dS}{dt}-\frac{\lambda}{4}\frac{dr^2}{dt}+kS=0 \tag{10}$$

where $S=\frac{r^2\theta}{2}$, $\lambda=2\omega\sin\phi$. When k is neglected this gives

$$S=S_0+\frac{\lambda}{4}(r^2-r_0^2) \tag{11}$$

S is negative for a cyclone and so increases in magnitude as the center is approached. Oberbeck's theory of circular cyclones is then given, and it is shown how Marchi has taken the unsymmetrical distribution of temperature into account. After a brief reference to vertical motions, attention is drawn to the fact that there is no general mathematical theory of atmospheric disturbances which takes into account the vertical motion and the unsymmetric distribution of temperature. It is not understood how the masses of air come to a state of more or less equilibrium in which the potential energy is large and then suddenly leave this state.

Margules's explanation of the observed low temperature gradients in the descending air current of an anticyclone is next given and the relation of anticyclones to the general circulation is considered. Marchi has indicated a method of calculating the path of a cyclone and Cordeiro has worked out an ingenious theory in which a cyclone is regarded as analogous to a top. The depressions and anticyclones of the higher latitudes can not be treated as closed vortices on account of the lack of symmetry, consequently Exner includes their variations under a general theory of the change of form of isobars.[1]

If we assume that the changes take place adiabatically we have

$$\frac{c_p}{AR}\frac{d}{dt}(\log T)=\frac{d}{dt}(\log p) \tag{12}$$

where

$$\frac{d}{dt}=\frac{\partial}{\partial t}+u\frac{\partial}{\partial x}+v\frac{\partial}{\partial y} \tag{13}$$

[1] Wien. Ber. 115, part 2a (1906); 116, part 2a (1907); 119 (1910). Meteorologische Zeitschrift 25 (1908), p. 57. The mathematical analysis is given very briefly in the encyclopedia article, so I have added some of the details.

On the other hand the barometric altitude formula

$$p = p_1\, e^{gH/RT} \tag{14}$$

gives

$$\frac{\partial p}{\partial t} = -\frac{pgH}{RT^2}\frac{\partial T}{\partial t} \tag{15}$$

where it is assumed that the pressure p_1 at height H is unaffected by nonperiodic changes.

Now when acceleration and friction are neglected the equations of horizontal motion become

$$2u\omega \sin \phi = \frac{1}{\rho}\frac{\partial p}{\partial y}, \quad -2v\omega \sin \phi = \frac{1}{\rho}\frac{\partial p}{\partial x} \tag{16}$$

Hence

$$u\frac{\partial p}{\partial x} + v\frac{\partial p}{\partial y} = 0$$

$$u\frac{\partial T}{\partial x} + v\frac{\partial T}{\partial y} = \frac{1}{2\omega\rho \sin \phi}\left(\frac{\partial p}{\partial y}\frac{\partial T}{\partial x} - \frac{\partial T}{\partial y}\frac{\partial p}{\partial x}\right)$$

and so (12) becomes

$$\frac{\partial p}{\partial t} = -\frac{gHc_p}{2\omega(c_p T + AgH)\sin \phi}\left(\frac{\partial p}{\partial x}\frac{\partial T}{\partial y} - \frac{\partial T}{\partial x}\frac{\partial p}{\partial y}\right).$$

This equation gives an approximate value for the rate of variation of the pressure at a given place. Exner also obtains a partial differential equation of type

$$\alpha\frac{\partial \alpha}{\partial t} = \frac{g}{\lambda}\left(\frac{\partial \alpha}{\partial x}\frac{\partial \beta}{\partial y} - \frac{\partial \beta}{\partial x}\frac{\partial \alpha}{\partial y}\right)$$

where

$$\alpha = \frac{\partial p^{1/\kappa}}{\partial z}, \qquad \beta = p^{1/\kappa}, \qquad \kappa = \frac{c_p}{AR}, \qquad \lambda = 2\omega \sin \phi.$$

A brief reference is next made to some graphical methods depending on the use of weather charts. Some reference may here be made to the recent work of English and French meteorologists.[1]

[1] See for instance, W. N. Shaw and R. G. K. Lempfert, The Life History of Surface Air-Currents, London (1906); W. N. Shaw, British Association Reports, Leicester (1907), where an account is given of the work of Durand Greville and Guilbert; Quart. Journ. Royal Meteorological Society, vol. xxix (1903), p. 233.

The article closes with an account of Margules' theories of the free and forced vibrations of an atmosphere in which horizontal motions only are considered. The difference equation

$$\left(n-2+\frac{3}{n+2}\right)a_n-\left(\frac{3}{n}k+\frac{4}{n+2}+n-3\right)a_{n-2}+\frac{4}{n}ka_{n-4}=0$$

which occurs in the work is solved by means of continued fractions according to the method of Laplace.

Attempts have been made recently to allow for vertical motions. Lamb[1] simplifies the problem by neglecting the curvature and rotation of the earth and determines the arbitrary constant occurring in the solution by using a boundary condition at an hypothetical limiting surface to the atmosphere. Jaerisch[2] on the other hand treats the problem in all its generality, and makes its solution depend on that of the differential equation

$$(n+2)r^2\frac{d^2Q}{dr^2}+\left[\frac{16\omega^2}{g}r-(n^2+2n-4)\right]r\frac{dQ}{dr} +\left[\frac{4\omega^2}{g}(2-3n)r+n(n-2)\right]Q=0$$

Instead of determining the unknown constants by means of a boundary condition he uses observed values for the quantities required. An approximate form of the above differential equation is used so as to simplify the solution. For the semidiurnal oscillation of the barometer the results appear to be fairly satisfactory.

[1] Proc. Roy. Soc., Ser. A, vol. 84 (1910), p. 551.
[2] Meteorologische Zeitschrift (1907), p. 481.

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XVII ELEMENTARY PROBLEMS IN METEOROLOGY (2D SERIES.)

By CHARLES F. VON HERRMANN,
District Editor, United States Weather Bureau.

[Dated Atlanta, Ga., Jan. 22, 1913.]

PROBLEM 26.[1]

Express by a concise mathematical formula the relations between the changes of pressure and volume of dry air considered as a perfect gas when the changes take place adiabatically.

Solution.—When a gas is compressed its temperature rises because the work performed upon it is converted into heat; or when it expands it performs work in overcoming external pressure, and its temperature falls. If no heat be removed or added the changes of volume and pressure do not follow the law of Boyle-Mariotte. That this must be true is evident from the following simple consideration: If a perfect gas be compressed in a cylinder whose walls are impervious to heat so that all the heat of compression is retained, a greater pressure will be required to reduce the volume, say to one-half, than if the gas were allowed to return to its initial temperature. How, then, are the pressures and volumes related when the changes take place adiabatically?

Poisson solved this problem by the aid of higher mathematics, and his equation of the adiabatic curve is given below. This equation should be familiar to every student of meteorology, and as the use of higher mathematics in the solution of this series of problems is excluded for the present, an elementary demonstration due to Albert Voss[2] is presented here.

Poisson's equation for an adiabatic change of pressure or volume is

$$\frac{p}{p_o} = \left(\frac{v_o}{v}\right)^k \tag{1}$$

in which p_o, v_o and p, v, are corresponding values of pressure and

[1] This numeration is a continuation of that in the Monthly Weather Review, January, 1907, p. 19. This second series is here published for the use of elementary students at Mount Weather Observatory.

[2] Elementare Darstellung der mechanischen Wärmetheorie für Gase, Berlin, 1887.

volume, and k is the ratio of the specific heats of air at constant pressure and at constant volume, or

$$k=\frac{c_p}{c_v}=\frac{0.2375}{0.1688}=1.41.$$

The pressures are expressed in units of weight, i. e., height of the barometer multiplied by the weight of unit volume of mercury; for normal pressure $13.596\times 760=10333$ kilograms per square meter.

The elementary proof of equation (1) follows.

A volume v_0 of a perfect gas under the pressure p_0 has a temperature $t_0°$. Then by equation (2), problem 11,[1]

$$p_0v_0=R(273+t_0°)=RT. \tag{2}$$

Under constant pressure a small quantity of heat Q, is added, causing a change in volume to v_1 and of temperature to $t_1°$. If c_p is the specific heat of air at constant pressure, for a change of temperature from $t_0°$ to $t_1°$, the quantity of heat added would be

$$Q=c_p(t_1°-t_0°) \tag{3}$$

Also

$$p_0v_1=R(273+t_1°) \tag{4}$$

From (2) and (4)

$$p_0v_1-p_0v_0=R(273+t_1°)-R(273+t_0°)=R(t_1°-t_0°)$$

Hence

$$(t_1°-t_0°)=\frac{p_0(v_1-v_0)}{R} \tag{5}$$

Substituting in (3)

$$Q=\frac{c_pp_0}{R}(v_1-v_0) \tag{6}$$

Now, maintaining the volume constant the same quantity of heat Q is withdrawn, causing a change of pressure to p_1 and of temperature to $t_2°$. If c_v is the specific heat of air at constant volume for a change of temperature from $t_1°$ to $t_2°$ the quantity of heat withdrawn is

$$Q=c_v(t_1°-t_2°) \tag{7}$$

Also

$$p_1v_1=R(273+t_2) \tag{8}$$

[1] Problems in Meteorology, Monthly Weather Review, December, 1906.

From (4) and (8),

$$p_o v_1 - p_1 v_1 = R(273 + t_1^\circ) - R(273 + t_2^\circ) = R(t_1^\circ - t_2^\circ) \text{ and}$$

$$(t_1^\circ - t_2^\circ) = \frac{v_1}{R}(p_o - p_1) \tag{9}$$

Substituting in (7)

$$Q = \frac{c_v v_1}{R}(p_o - p_1) \tag{10}$$

In equations (6) and (10) we have two values of Q which must be equal, or

$$\frac{c_p p_o}{R}(v_1 - v_o) = \frac{c_v v_1}{R}(p_o - p_1) \tag{11}$$

which reduces to

$$-\left(\frac{c_p}{c_v}\right)\frac{(v_1 - v_o)}{v_1} = \frac{(p_1 - p_o)}{p_o} \tag{12}$$

and taking $\frac{c_p}{c_v} = k$

$$-k\frac{(v_1 - v_o)}{v_1} = \frac{(p_1 - p_o)}{p_o} \tag{13}$$

By means of the last equation each pair of corresponding values of v_1, p_1, can be found, determined by the condition that the algebraic sum of the heat added and subtracted shall be zero.

Now consider that an infinitesimal quantity of heat is added an infinite number of times at constant pressure and withdrawn again at constant volume. The algebraic sum of the heat added and withdrawn will still be zero, and also at each single operation the extremely small quantities of heat added and withdrawn approach zero, and the changes may be considered to follow adiabatically.

By the aid of equation (13) we now compute the pressures, p_1, p_2, p_3, ... p_{n-1}, p_n, and the volumes, v_1, v_2, v_3, . . . v_{n-1}, v_n, resulting from these infinitesimal changes; then

$$\frac{p_1 - p_o}{p_o} = -k.\frac{v_1 - v_o}{v_1}$$

$$\frac{p_2 - p_1}{p_1} = -k\frac{v_2 - v_1}{v_2}$$

$$\frac{p_3 - p_2}{p_2} = -k\frac{v_3 - v_2}{v_3}$$

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$$\frac{p_n - p_{n-1}}{p_{n-1}} = -k.\frac{v_n - v_{n-1}}{v_n}$$

Let it be assumed also that the infinitesimal quantities of heat are so proportioned that the changes of pressure are always the same fraction of the preceding pressure, or that

$$\frac{p_1 - p_0}{p_0} = \frac{p_2 - p_1}{p_1} = \ldots\ldots \frac{p_n - p_{n-1}}{p_{n-1}} = \frac{q}{n} \tag{14}$$

in which $\frac{q}{n}$ continually diminishes with increasing n and for $n = \infty$ becomes infinitesimal. Then

$$\frac{p_1 - p_0}{p_0} = \frac{q}{n} \therefore p_1 = p_0\left(1 + \frac{q}{n}\right)$$

$$\frac{p_2 - p_1}{p_1} = \frac{q}{n} \therefore p_2 = p_1\left(1 + \frac{q}{n}\right)$$

$$\vdots \qquad \vdots \qquad \vdots \qquad \vdots$$

$$\frac{p_n - p_{n-1}}{p_{n-1}} = \frac{q}{n} \therefore p_n = p_{n-1}\left(1 + \frac{q}{n}\right)$$

By successive substitutions

$$p_n = p_0(1 + q/n)^n \tag{15}$$

When $n = \infty$ the expression $(1 + q/n)^n$ approaches the limit e^q where e is the Naperian base 2.71828, consequently

$$p_n = p_0 e^q \tag{16}$$

In quite a similar manner,

$$-k.\frac{v_1 - v_0}{v_1} = -k.\frac{v_2 - v_1}{v_2} \ldots = \frac{q}{n}$$

or

$$-k.\frac{v_1 - v_0}{v_1} = \frac{q}{n} \therefore \frac{v_0 - v_1}{v_1} = \frac{q}{kn}.$$

Hence

$$v_0 = v_1(1 + q/kn)$$

$$v_1 = v_2(1 + q/kn)$$

$$\vdots \qquad \vdots$$

$$v_{n-2} = v_{n-1}(1 + q/kn)$$

$$v_{n-1} = v_n\ (1 + q/kn) \therefore v_n = \frac{v_{n-1}}{(1 + q/kn)}$$

By successive substitution

$$v_n = \frac{v_0}{(1+q/kn)^n} \tag{17}$$

When $n=\infty$, $(1+q/kn)^n$ approaches the limit $e^{q/k}$. Hence

$$v_n = \frac{v_0}{e^{q/k}} \therefore v_n e^{q/k} = v_0 \therefore v_n{}^k e^q = v_0{}^k \tag{18}$$

From (16) and (18)

$$p_n v_n{}^k e^q = p_0 e^q v_0{}^k \therefore p_n v_n{}^k = p_0 v_0{}^k \therefore \frac{p_n}{p_0} = \frac{v_0{}^k}{v_n{}^k} = \left(\frac{v_0}{v_n}\right)^k \tag{19}$$

Which is Poisson's equation. (*Müller-Pouillet, Lehrbuch der Physik, Wärmelehre, p. 647.*)

Problem 27.

Dry air at the earth's surface at a temperature of 0°C. under normal pressure is compressed to nine-tenths of its original volume, no heat being added or lost except as the result of compression, what is its temperature?

Solution.—

$$\frac{p}{p_0} = \left(\frac{v_0}{v}\right)^k \tag{1}$$

Multiplying both members by $\frac{v}{v_0}$

$$\frac{p}{p_0}\left(\frac{v}{v_0}\right) = \frac{v}{v_0}\left(\frac{v_0}{v}\right)^k = \left(\frac{v_0}{v}\right)^{k-1} \tag{2}$$

Also by the law of Boyle-Mariotte $p_0 v_0 = RT$ and $pv = RT'$; dividing

$$\frac{pv}{p_0 v_0} = \frac{RT'}{RT} = \frac{T'}{T} \tag{3}$$

Comparing with (2)

$$\frac{T'}{T} = \left(\frac{v_0}{v}\right)^{k-1} \text{ or } T' = T\left(\frac{v_0}{v}\right)^{k-1} = T\left(\frac{v_0}{v}\right)^{0.41} \tag{4}$$

In the problem, $T = 273° + 0° = 273$; v_0 = original volume, 1; $v = 9/10$ of original volume; hence

$$T' = 273\left(\frac{10}{9}\right)^{0.41}$$

Log T' = Log. 273 + 0.41 Log. 10/9
= 2.43616 + 0.41 × .04575
= 2.43616 + 0.01876 = 2.45492
T' = 285°

Accordingly the rise in temperature is 285° − 273° = 12°

PROBLEM 28.

Dry air at the earth's surface at a temperature 0° C., under normal pressure p_o ascends rapidly to an altitude where the pressure becomes $\frac{1}{2}$ p_o, no heat meanwhile being received or lost except in the work of expansion, what is its temperature?

Solution.—It is to be observed that Poisson's formula is applicable without change to all cases whether of compression or expansion.

$$\frac{p}{p_o}=\left(\frac{v_o}{v}\right)^k \tag{1}$$

Extracting the kth root

$$\left(\frac{p}{p_o}\right)^{\frac{1}{k}}=\frac{v_o}{v}$$

Multiplying both members by $\frac{p_o}{p}$

$$\frac{p_o v_o}{p\ v}=\frac{p_o}{p}\left(\frac{p}{p_o}\right)^{\frac{1}{k}}=\left(\frac{p_o}{p}\right)^{(1-1/k)}=\left(\frac{p_o}{p}\right)^{\frac{k-1}{k}} \tag{2}$$

Also by the law of Boyle-Mariotte $p_o v_o=RT$ and $pv=RT'$; dividing

$$\frac{p_o v_o}{p\ v}=\frac{T}{T'}. \tag{3}$$

Substituting in (2)

$$\frac{T}{T'}=\left(\frac{p_o}{p}\right)^{\frac{k-1}{k}} \tag{4}$$

and

$$\frac{p_o}{p}=\left(\frac{T}{T'}\right)^{\frac{k}{k-1}}=\left(\frac{T}{T'}\right)^{3.44} \tag{5}$$

Whence

$$T'=T\left(\frac{p}{p_o}\right)^{\frac{k-1}{k}}=T\left(\frac{p}{p_o}\right)^{0.2907} \tag{6}$$

With an initial temperature $T=273+0°$, pressures p_o and $\frac{1}{2}$ p_o, we have by (6)

$$T'=273\left(\frac{1}{2}\right)^{0.2907}$$

$$\begin{aligned}\text{Log. } T' &= \text{Log. } 273+0.2907 \text{ Log. } \tfrac{1}{2}\\ &=2.43616-0.08751\\ &=2.34865\\ T' &=223°\end{aligned}$$

The temperature of the air is then $223°-273°=-50°$ C

Problem 29.

Dry air at the earth's surface under normal pressure at a temperature of 0° C. rises rapidly (adiabatically) to an altitude where its volume becomes doubled; what is its temperature?

Solution.—Applying equation (2), problem 27, since $v_0 = 1$ and $v = 2$,

$$T' = T\left(\frac{v_0}{v}\right)^{0.41} \therefore T' = 273\left(\frac{1}{2}\right)^{0.41}$$

$$\begin{aligned} \text{Log. } T' &= \text{Log. } 273 + 0.41 \text{ Log. } \tfrac{1}{2} \\ &= 2.43616 - 0.12342 \\ &= 2.31274 \\ T' &= 205.5°. \end{aligned}$$

The fall in temperature of the air is $205.5 - 273° = -67.5°$ C.

Note.—The student should be able to explain why the air cools so much more when it expands adiabatically to double its initial volume than when the pressure is diminished one-half. In the former case, under what pressure is the air finally?

Problem 30.

If a pressure of 10 atmospheres be suddenly applied to the compression of air under standard pressure at a temperature of 60° F., what would be the temperature of the compressed air? (Ferrel.)

Solution.—Applying equation (6), problem 28, since $p_0 = 1$, $p = 10$ and $T = \frac{5}{9}(60 - 32) = 15.56°\text{ C.} + 273 = 288.56°$

$$\begin{aligned} T' &= 288.56°\ (10)^{0.2907} \\ \text{Log. } T' &= \text{Log. } 288.56 + 0.2907 \text{ Log. } 10 \\ &= 2.46024 + 0.2907 = 2.75094 \\ T' &= 563.6° \end{aligned}$$

Hence the change in temperature of the air is $563.6° - 273° = 290.6°$.

Problem 31.

If the temperature of dry air is 20° C. and the pressure 760 millimeters, what would be the temperature when the pressure is reduced to 600 millimeters? To 500 millimeters?

Problem 32.

Construct the adiabatic and the isothermal curves which pass through the given point $p_0 v_0$.

Solution.—The required construction is given in figure 1, page 335. Through the origin O draw the line OF making any convenient angle $FOX = \alpha$ with the axis OX. In the figure $FOX = 15°$. Also draw OG making an angle $GOY = \beta$ with the axis OY. The angles α and β are related as follows:

$$(1 + \tan.\ \beta) = (1 + \tan.\ \alpha)^k = (1 + \tan.\ \alpha)^{1.41}$$

By a simple computation if α is assumed to be 15°, β is found to be 21°41′.

If the volume at the given point be represented by $Oc_0 = v_0$ and the pressure by $Oq_0 = p_0$, the given point is located at p_0. Draw through p_0 the lines $p_0\ q_0\ a_0$ and $p_0\ c_0\ b_1$ parallel to the axis, and at the point b_1 draw b_1c_1 forming an angle of 45° with $b_1c_0p_0$; also from q_0 draw q_0a_1 forming an angle of 45° with $a_0q_0p_0$; from the points a_1 and c_1 draw parallel lines to the axes, $a_1q_1 1$ and $b_2c_1 1$, their point of intersection gives point 1 on the adiabat. Proceed in a similar matter to c_2 and a_2 the intersection of the parallels through these points giving point 2 on the adiabat.

On the other hand for compression draw a_0q^1 forming an angle of 45° with $a_0q_0p_0$ and c_0b_0 forming the same angle with $b_1c_0p_0$. The intersection of the parallels through b_0 and q^1 give point 1^1 on the

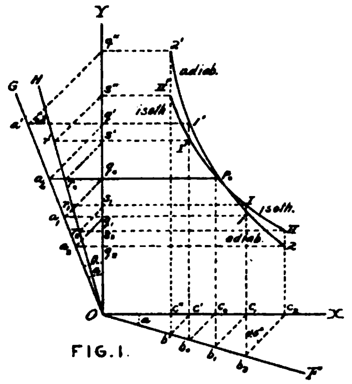


FIG. 1.

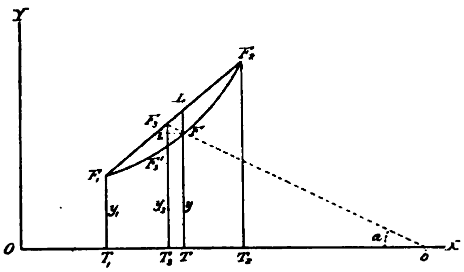


FIG. 2.

same adiabatic curve. In a similar manner as many other positions on the adiabat 2^1, 1^1, p_0, 1, 2 as desired may be determined.

Proof:

$$\tan.\ \alpha = \frac{c_0b_1}{Oc_0} = \frac{c_0c_1}{Oc_0} = \frac{Oc_1 - Oc_0}{Oc_0} = \frac{v_1 - v_0}{v_0}$$

Hence

$$(1 + \tan.\ \alpha) = \frac{v_1}{v_0}$$

Also

$$\tan.\ \beta = \frac{q_1a_1}{Oq_1} = \frac{q_1q_0}{Oq_1} = \frac{Oq_0 - Oq_1}{Oq_1} = \frac{p_0 - p_1}{p_1}$$

Hence

$$(1 + \tan.\ \beta) = \frac{p_0}{p_1}.$$

Since the relation $(1+\tan.\ \beta)=(1+\tan.\ \alpha)^k$ subsists by construction, we have

$\frac{p_0}{p_1}=\left(\frac{v_1}{v_0}\right)^k$ or $p_0v_0^k=p_1v_1^k$, therefore 1 (p_1v_1) is a point on the adiabat.

Similarly

$$\tan.\ \beta=\frac{q_0a_0}{Oq_0}=\frac{q_0q^1}{Oq_0}=\frac{Oq^1-Oq_0}{Oq_0}=\frac{p^1-p_0}{p_0}$$

or

$$(1+\tan.\ \beta)=\frac{p^1}{p_0}$$

Also

$$\tan.\ \alpha=\frac{c^1b_0}{Oc^1}=\frac{c^1c_0}{Oc^1}=\frac{Oc_0-Oc^1}{Oc^1}=\frac{v_0-v^1}{v^1}$$

or

$$\tan.\ \alpha=\frac{v_0}{v^1}$$

Again since $(1+\tan.\ \beta)=(1+\tan.\ \alpha)^k$ we have

$$\frac{p^1}{p_0}=\left(\frac{v_0}{v^1}\right)^k \text{ or } p^1(v^1)^k=p_0v_0^k$$

Therefore 1^1 is also a point on the adiabat. Q. E. D.

NOTE.—For $k=1$, or the angle $FOX=HOY(\alpha=\beta)$, a similar construction gives the isothermal $II^1I^1p^0$ $I.II.$ Exercise for the student: Construct the isothermal line through the points p_0v_0 and prove that for expansion the isothermal is above the adiabat, but for compression below it. (Müller-Pouillet's Lehrbuch der Physik, Wärmelehre, pp. 647 to 654).

If the ascending air contains vapor of water, its specific heat is somewhat increased, and consequently the rate of cooling is diminished slightly. Show that as long as condensation does not take place the effect is quite small. As an extreme case compute the specific heat of moist air when the vapor pressure is 20 millimeters and the pressure 760 millimeters.

Suggestion, by problem 16, equation (3) the amount of vapor in a kilogram of saturated air is (0.622e)/(b − 0.378e), hence the dry air is 1 − (0.622e)/(b − 0.378e). Specific heat of dry air 0.238, of aqueous vapor 0.481. Hence the specific heat of the moist air is

$$0.238\left(1-\frac{(0.622\text{e})}{(\text{b}-0.378\text{e})}\right)+0.481\left(\frac{0.622\text{e}}{(\text{b}-.378\text{e})}\right)$$

How much does this differ from 0.238? (Hann's Lehrbuch, 1st ed., footnote (3), p. 754.)

PROBLEM 33.

Calculate the temperature reached and the amount of moisture condensed when saturated masses of air at 0° C. and 25° C. are mixed.

Solution.—Remarks: When two masses of saturated air at different temperatures are mixed, some condensation must occur, and this fact formed the basis of Hutton's theory of rainfall. The following is an example of the argument at first used to support the theory. Suppose equal masses of saturated air at 0° C. and 25° C. to be mixed. A cubic meter of saturated air at 0° contains 4.90 grams of varpor, and a cubic meter at 25° contains 22.84 grams. After mixing the temperature must be the mean of 0° and 25°, or 12.5°, and the average vapor contents must be 1/2(4.90+22.84), or 13.87 grams. But at the temperature 12.5° C. a cubic meter of saturated air contains only 10.94 grams of water. Accordingly the amount lost by condensation must be 13.87−10.94, or 2.93 grams.

In this statement no account has been taken of the latent heat liberated by the condensed vapor. The opponents of Hutton's theory went to the other extreme of denying that any condensation whatever would take place. For the latent heat liberated by the condensation of 2.93 grams of vapor is sufficient to raise the temperature of the mixture to 18° C.[1]

At 18° a cubic meter of saturated air contains 15.30 grams, and as the mixture assumed contains an average of only 13.87 grams, it is not even saturated. The fallacy here is the assumption that 2.93 grams of vapor will be condensed. A smaller portion of the vapor will be condensed, and hence the liberated latent heat will not be sufficient to warm the air to 18° C.

There is no simple algebraic method of computing directly how much vapor will be condensed, but von Bezold has given an interesting graphic solution of the problem.[2]

In figure 2, the lengths of the ordinates, $y_1 = F_1T_1$, $y = FT$, $y_2 = F_2T_2$, represent the amount of vapor in a kilogram of saturated air at the corresponding temperatures T_1, T, and T_2. Through the middle point of the line F_1F_2 joining the points on the saturation curve for

[1] The specific heat of dry air at constant pressure is 0.238 calorie, or for the moist air about 0.240 calorie. One cubic meter of dry air weighs 1.293 kilograms, and requires 1.293×0.238 or 0.31 calorie to raise its temperature 1° C. The latent heat liberated by 2.9 grams of condensed vapor is 2.9×600=1,740 gram-calories, or 1.74 kilogram-calories, which would warm up 1 kilogram of air 1.74/0.31 or 5.6° C. (Hann's Lehrbuch, 1st ed., p. 243.)

[2] See the translation of von Bezold's paper by Prof. Abbe, in The Mechanics of the Earth's Atmosphere, 1891, p. 265. Also, Short Memoirs on Meteorological Subjects, Annual Report Smithsonian Inst., 1877, p. 388-392. Also Hann's Lehrbuch der Meteorologie, 1st ed., p. 243.

the temperatures of the two air masses mixed, draw a line F_3b, making an angle of 21° with the axis of abscissas OX. This line will cut the saturation curve at the point F, and the corresponding ordinate y will represent the amount of moisture retained as vapor in the air after mixing, at the temperature T. The amount of vapor condensed is therefore $y_3 - y = F_3i$; and the temperature of the mixture is T. If the diagram is drawn to scale the amount of vapor condensed and the temperature may be measured with considerable accuracy.

Returning to the illustration used, the mixture of saturated air at 0° and 25°, it will be found by construction that the temperature of the mixture will be 14.9° C. (instead of the mean 12.5°). Saturated air at that temperature contains 12.66 grams of vapor. The amount condensed is $13.87 - 12.66 = 1.21$ grams. If the quantity of mixed air amounted to 1,000 cubic meters the precipitation would be 1,210 grams on a square meter, or 1.2 millimeters (about 0.05 inch). The mixture of air masses at such extreme temperatures, moreover, is quite impossible, and the process of mixture can give rise only to the formation of clouds.

The angle which the line F_3b makes with the axis of abscissas is determined as follows: Let it be assumed that at first the whole quantity of vapor, y_3, is actually present in the mixture, and that gradual condensation of the excess of vapor takes place accompanied by simultaneous warming.

Let dy designate the extremely small quantity of vapor which becomes condensed from 1 kilogram (1,000 grams) of saturated air by the small change of temperature dt; r, the liberated latent heat and c, the specific heat of moist air, then since condensation is produced by a fall in temperature, but the liberated latent heat causes a rise, we have, using the simplest notation of calculus

$$1000c.dt = -r.dy$$

By the diagram the amount of vapor condensed is $y_3 - y$, (dy) and the temperature change is $(t - t_3)$, (dt), and since the rise in temperature is only a few degrees, c/r may be considered constant; we obtain

$$y_3 - y = \frac{10^3c}{r}(t - t_3)$$

in which $(y_3 - y) = Fi =$ sin angle F_3Fi, which is equal to the angle

made by the line F_2b with the axis OX; $(t-t_2)=iF=\cos$ angle F_2Fi. Therefore

$$\sin a=\frac{10^3c}{r}\cos a, \text{ or } \frac{\sin a}{\cos a}=\tan. a=\frac{10^3c}{r}$$

In which c is the specific heat of moist air, about 0.240, and r, the latent heat of condensation, above freezing in round numbers 600 calories, and below freezing 680 calories. Substituting these values we have

$$\text{for } t>0°, \tan. a=240/600=0.400, \text{ the tan. of } 21°$$

$$\text{for } t<0°, \tan. a :: 240/680=0.353, \text{ tan. of } 19.4°$$

NOTE.—The paper by von Bezold contains the solution of several other interesting problems of mixture which the teacher may utilize. For example, show that the mixture of saturated warmer with unsaturated colder air gives rise to condensation much more readily than the mixture of saturated colder with unsaturated warmer air. (Formation of fog.) Show that the cooling in ascending air currents is much more effective in producing precipitation than the process of mixture.

PROBLEM 34.

By the aid of Neuhoff's adiabatic diagram discuss the changes that take place in the condition of moist air as it rises in the atmosphere, expanding adiabatically, assuming that the initial pressure is 760 millimeters, initial temperature 20° C., and relative humidity 86 per cent.[1]

Solution.—1. The question of the changes which air will experience as it rises or sinks in the atmosphere is complicated by the presence of aqueous vapor, so that Poisson's equation is no longer strictly applicable. For, as a result of cooling, the air becomes saturated, condensation takes place with liberation of latent heat which diminishes the rate of cooling, and water is precipitated as rain, ice, or snow. The different stages of the process have been characterized by Hertz as the dry stage, the rain stage, the hail stage, and the snow stage.

Dr. Neuhoff starts not from the usual assumption of thermodynamics, which considers a unit weight, 1 kilogram of moist air, as the basis of computation, but considers separately 1 kilogram of dry air and x kilograms of aqueous vapor. The quantity x is called the "mixing ratio." For the dry stage the following simple equation is applicable:

$$\log. p-m_1 \log. T=\log. p_0-m_1 \log. T_0=\text{constant.} \tag{4}$$

which is identical with Poisson's equation except that the factor m has various values depending upon the mixing ratio x.

[1] Adiabatic Changes of Condition of Moist Air and Their Determination by Numerical and Graphic Methods. By Dr. Otto Neuhoff. Translated by Cleveland Abbe in The Mechanics of the Earth's Atmosphere, Third Collection, pp. 430–493.

For the condensation stage:

$$\log. p' - \frac{a}{p'} - m_{11} \log. T = \log. p'_0 - \frac{a_0}{p'_0} - m_{11} \log. T'_0 = \text{constant}. \quad (10)$$

in which a is designated the condensation factor, and m_{11} the humidity factor.

The student is referred to the original paper for the deduction of these equations which present no great mathematical difficulties.

2. In the adiabatic diagram of Neuhoff (fig. 3), the relations between pressure and temperature for adiabatic changes of condition of moist air are expressed by a network of squares with unit length 1° for temperature and 100 meters for differences of altitude.

The adiabats of the dry stage are straight lines and run parallel to the diagonals of the small squares. They are drawn for every 10° and interpolation for other temperatures is simple.

The adiabats of the condensation stage are curved lines, indicated by dot and dash, and are drawn for every 2°.

The pressure lines are drawn through for each difference of pressure of 100 millimeters, and the remaining lines at intervals of 10 millimeters are indicated on the two sides of the diagram by short dashes. The isobars run in straight lines which are inclined downward toward the lower temperature and separate farther from each other as the altitude increases.

For the determination of the points of transition from the dry stage to the condensation stage, as well as the quantity of water present under given conditions, the curves of constant quantity of moisture needed for saturation are indicated by dotted lines for each 5 grams.

3. Under the conditions of the problem, the air having an initial pressure of 760 millimeters, temperature 20° C., and relative humidity 86 per cent begins its ascent at the point A in figure 3. At 20° the amount of moisture needed for saturation is readily found by interpolation to be about 14.6 grams, but as the relative humidity is 86 per cent the amount actually present is 12.5 grams. Hence the point of saturation and beginning of condensation will be found by following the adiabat for the dry stage until it intersects the gram line of saturation representing 12.5 grams at the point B.

From the diagram by interpolation the conditions at B at the end of the dry stage are found to be: Temperature 17° C.; corresponding vapor pressure 14.4 millimeters; amount of water present 12.5 grams; pressure 733 millimeters; and altitude 300 meters.

The rain stage: The air is now saturated, the condensation of vapor begins and during the further expansion of the air it continues to be saturated. In order to ascertain its condition when the temperature has fallen, for example, to 10° C. the condensation adiabat is followed from the point B to its intersection with the isothermal line of 10° at C. Here the conditions are found to be: Pressure 616 millimeters; and since the temperature is 10° the vapor pressure of saturation is 9.2 millimeters; amount of water present 9.4 grams, therefore the quantity condensed is $12.5 - 9.4 = 3.1$ grams; the altitude is 1,710 meters. The rain stage terminates when the temperature has fallen to 0°, point D, where the conditions are pressure 487 millimeters, vapor pressure corresponding to 0°, 4.6 millimeters, hence quantity of vapor present 5.9 grams, and amount present as rain 6.6 grams; altitude 3,700 meters.

The hail stage: Assuming that the water condensed up to the point D, or 6.6 grams, has remained suspended in the air, it will now freeze and the temperature will remain constant until all the water is frozen, which will usually require only a very short time. A small quantity of the water present will be evaporated. After all the water is frozen the snow stage begins. The isothermal change of altitude at 0° C. is proportional to the quantity of water present, and is practically 30 meters for each gram of freezing water. Therefore we ascend 190 meters on the isothermal line of 0° to the point E where the conditions are pressure 476 millimeters; the vapor pressure remains that of saturation at 0° or 4.6 millimeters; quantity of vapor present 6.1 grams; hence the amount of ice is $12.5 - 6.1 = 6.4$ grams; altitude 3,890 meters.

The snow stage: As the air continues to ascend and cool further condensation of vapor occurs in the form of snow and the process is similar to that which prevailed during the rain stage. If the expansion goes on until the temperature becomes −20° C. the final pressure becomes 312 millimeters, quantity of vapor 1.8 grams, ice, which has remained suspended, 6.4 grams; hence the amount of snow is 4.3 grams; altitude 7,200 meters.

4. If the condensed water does not remain suspended but becomes separated from the ascending air column, we have to do with pseudo-adiabatic conditions (von Bezold). Dr. Neuhoff shows that the values of the pressures for the pseudo-adiabat are always higher than for the adiabat for the same temperature, but the differences are small and need not be considered except in very rigorous investi-

gations (Original paper, p. 480). The characteristic difference is the omission of the hail stage in the pseudo-adiabatic changes of condition.

Suggestion: If the relative humidity of the air at the beginning is 30 per cent instead of 86 per cent, the air will at once pass from the dry stage to the snow stage, reaching saturation at a temperature of $-1.2°$ C. Ascertain from the diagram its pressure and altitude. Then compute by Poisson's equation the pressure and altitude at which dry air as a perfect gas with initial temperature 20° and pressure 760 millimeters will reach zero.

Problem 34a.

By the aid of the adiabatic diagram study the characteristics of the foehn wind, assuming an initial temperature of 14° C. and a relative humidity of 60 per cent. The precipitation all falls away, and after attaining the summit of a mountain ridge at an altitude of 3,000 meters, the air sinks to the initial level, undergoing adiabatic compression. What is its final temperature and humidity by Neuhoff's diagram?

Problem 35.

The acceleration of gravity at the earth's surface is 9.806 meters per second per second. What is the attractive force of the sun at the distance of the earth, or how far does the earth fall toward the sun in 1 second?

Solution.—1. By actual measurement it has been found that a body falling freely to the earth's surface from a state of rest will at the end of 1 second acquire a velocity which, if the attractive force of gravity were at the end of that second suddenly arrested, would carry the body during the next second over 9.806 meters. This is normal gravity at latitude 45° and sea level. At the end of 2 seconds the velocity acquired would be 2×9.806; at the end of 3 seconds, 3×9.806; and at the end of t seconds, $t \times 9.806$. Usually the constant 9.806 is represented by g, seconds by t, and velocity by v, then

$$v = gt \qquad (1)$$

The velocity acquired at the end of 5 seconds is $5g$, and at the end of 6 seconds $6g$; during the sixth second the velocity has gradually and continually increased from $5g$ to $6g$; the distance traversed during the sixth second will be the same as if the body had traveled the entire second with a constant mean velocity of $1/2(5g+6g)$ or $5.5g$ meters; again, the space traversed during the fourth second, by the same reasoning would be $1/2(4g+5g)$, or $4.5g$; finally for the first second, $1/2(0g+1g)$, or $0.5g$. Arranging the successive values in order, the law readily appears:

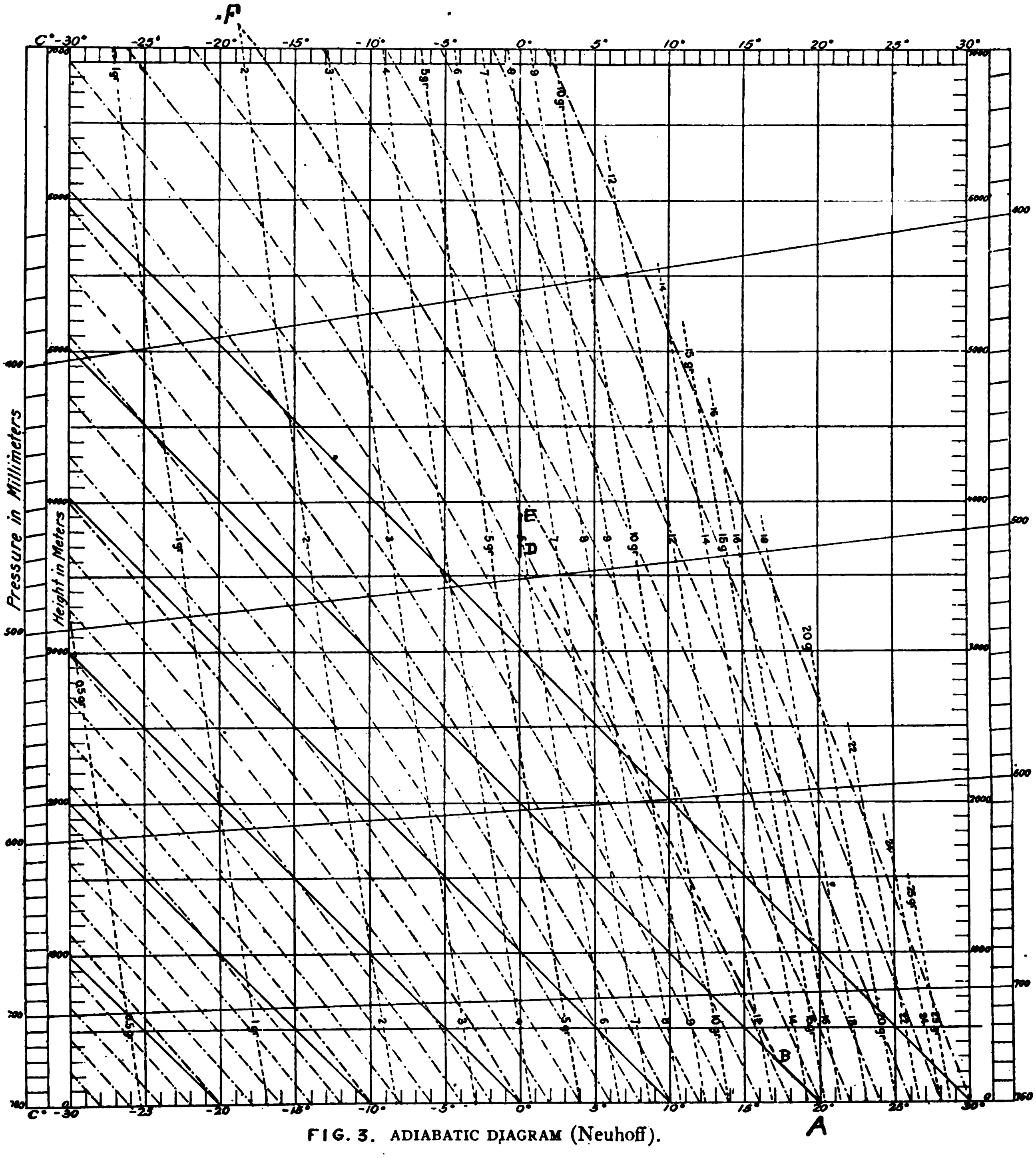


FIG. 3. ADIABATIC DIAGRAM (Neuhoff).

83729–13. (To face page 342.)

Space passed over in 1 second $= 0.5g = 1 \times 1/2g$.
Space passed over in 2 seconds = space passed over in first second, plus space passed over in second second, $0.5g + 1.5g = 2g = 4 \times 1/2g$.
Space passed over in 3 seconds $= 0.5g + 1.5g + 2.5g$ or $4.5g = 9 \times 1/2g$.

In general

Space passed over in t seconds $= t^2 \times 1/2g$.

Or

$$s = t^2 1/2g \quad (2)$$

(Watson's Text Book of Physics, p. 33–35.)

2. Consider the movement of a planet in its orbit, as the earth revolving around the sun. The actual linear velocity of the planet is the length of its orbit divided by the time required to make a complete revolution; or, since the circumference of a circle is $2\pi r$, and the time of revolution is the length of a siderial year in seconds, or T, we have

$$v = 2\pi r / T \quad (3)$$

It is convenient, however, to express this as an angular velocity (w) by assuming the radius (r) of the circle to be unity (i. e. a radian) when equation (3) reduces to

$$v/r = w = 2\pi / T \quad (4)$$

For example, in the case of the earth, T, the time in seconds is 1 siderial year, 365 days, 6 hours, 9 minutes, and 9 seconds (31,558,149 seconds). Therefore from (4)

$$w = \frac{2 \times 3.1416}{31,558,149} = 0.000,000,199,1$$

This value of w, the angular velocity of the earth, or the part of the radius of its orbit which it describes in 1 second of time, is almost a constant of nature. During the past thousand years the length of the day has probably not changed as much as the one one-thousandth of a second.

To obtain the actual linear velocity of the earth multiply the above expression (w) by the length of the radian, in this case by r, the radius of the earth's orbit, giving

$$v = rw \quad (5)$$

The radius of the earth's orbit in meters is 149,668,550,000; the result gives the actual velocity of the earth, or 29,779.1 meters per

second. If the radius is expressed in miles (93,000,000) the velocity is 18.5 miles per second.

3. While the planet moves from E to E^1 in 1 second it passes over the distance EE^1, see Fig. 4. Draw an arc w, with unit radius Sd. By simple proportion

$$Sd : \text{arc } w :: SE : \text{arc } EE^1 \therefore EE^1 = w.SE/Sd$$

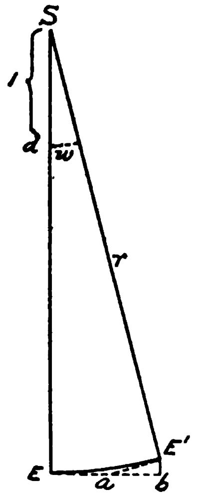


FIG. 4.

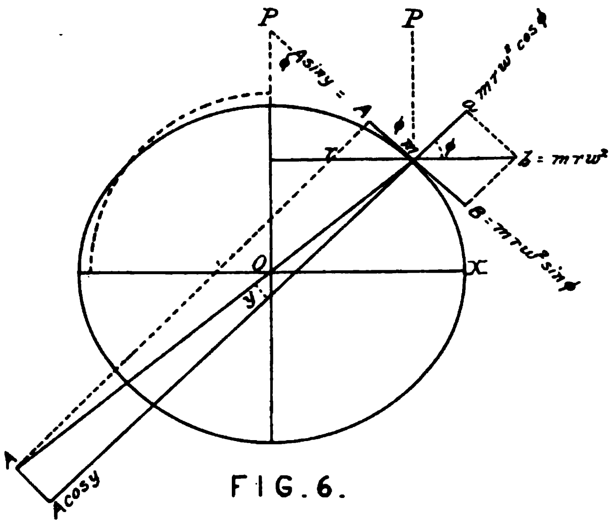


FIG. 6.

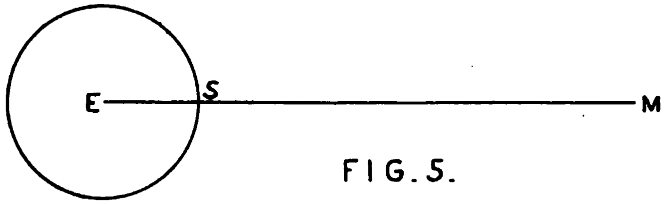


FIG. 5.

But SE is r the radius of the earth's orbit, and w is the angular velocity of the earth, therefore

$$EE^1 = rw \tag{6}$$

If the attraction force of the sun were destroyed at the beginning of the second, the planet would during that second not reach E^1 but would move in a straight line to b, making $EE^1 = Eb$. The sun, therefore in 1 second has drawn the planet toward itself through the

distance bE^1. This is the distance the planet would have fallen toward the sun in 1 second from the point E had it possessed no progressive motion. Actually the line bE^1 is not continuous with the radius SE^1 but in the case of the earth and sun is very nearly so, on account of the very small angle ESE^1 which is only 0.041 second of arc, and the great length of the line SE^1 as compared with Eb (93,000,000 to 18 miles).

To express the length of bE^1 in terms of the radius r and the angular speed of revolution, w, draw at E^1 the tangent aE^1. Then, by geometry, the point a will be half-way between E and E^1, so that

$$aE^1 = ab = 1/2,\ Eb = 1/2\ EE^1 = 1/2\ rw \text{ (by 6)}$$

Or

$$aE^1 = 1/2\ rw \tag{7}$$

But the line bE^1 may be considered as part of a circle drawn about a as a center, with radius aE^1, and subtends an angle baE^1, or $bE^1 = aE^1 \times baE^1$. The angle baE^1 between the two tangents aE^1 and bE is equal to the angle ESE^1, so that $baE^1 = w$, and since by (7) $aE^1 = 1/2\ rw$, we have

$$bE^1 = aE^1 \times baE^1 = 1/2\ rw \times w = 1/2\ rw^2 \tag{8}$$

Therefore $1/2\ rw^2$ is the space passed over by a planet falling toward the sun in 1 second; but by paragraph 1 the velocity acquired at the end of 1 second or the acceleration a^1 will be twice as great, therefore

$$a^1 = rw^2 \tag{9}$$

The acceleration of the earth toward the sun in 1 second is equal to the radius of the earth's orbit multiplied by the square of the angular velocity.

4. Consider the path of the earth around the sun to be a circle, which it is approximately. From equation (4) and equation (9) we have

$$a^1 = 4\pi^2 r / T^2 \tag{10}$$

Employing the proper values for r and T we obtain

$$\frac{4 \times 3.1416^2 \times 149{,}669{,}550{,}000}{31{,}588{,}149 \times 31{,}558{,}149} = 0.00593 \text{ meter per second per second.}$$

This is equal to 0.01935 foot per second per second. The earth falls toward the sun in 1 second one-half of this, or 0.00296 meter, about 0.009675 foot or 0.116 inch. Therefore, in traveling a distance of

18.5 miles the earth falls toward the sun about one-ninth of an inch. (Sprung's Lehrbuch der Meteorologie, pp. 3–7.)

Problem 36.

What is the attraction of gravity or acceleration at the surface of the sun? At the surface of the moon?

Solution.—1. According to the law of Newton the attraction of gravity varies inversely as the squares of the distances (the forces being assumed concentrated at the centers of gravity). Let R be the radius of the sun, r the distance of the earth from the sun, a^1 the acceleration produced by the sun at the distance of the earth, as found in problem 35, and A^1 the acceleration at the surface of the sun, then

$$A^1 : a^1 :: r^2 : R^2 \text{ or } A^1 = \frac{a^1 r^2}{R^2} \tag{1}$$

Substituting for a^1 its value $4\pi^2 r/T^2$ (equation 10, problem 35), gives

$$A^1 = 4\pi^2 r^3/T^2 R^2 \tag{2}$$

In which

R, radius of sun is 696,325,511 meters (432,675 miles). (Todd's New Astronomy, p. 261.)

r, radius of earth's orbit, 149,669,550,000 meters (93,000,000 miles).

π, 3.1416..

Then

$$A^1 = \frac{4 \times 3.1416^2 \times 149,669,550,000^3}{31,558,149^2 \times 696,325,511^2}$$

or

$$A^1 = \frac{4 \times 3.1416^2 \times 149,669,550,000}{31,558,149^2} \times \left(\frac{149,669,550,000}{696,325,511}\right)^2$$

The value of the first part was found in problem 35 to be 0.00593 meter, and the value of the second part is the square of 214.9.

$$A^1 = 0.00593 \times 214.9^2 = 273.9 \text{ meters.}$$

In falling without friction on the earth a body acquires at the end of the first second a velocity of 9.806 meters per second, but on the sun's surface a velocity of 273.8 meters, or nearly 28 times as great.

2. By Sir Isaac Newton's law the superficial gravity on the moon's surface is to that on the earth's surface directly as the mass of the two bodies and inversely as the squares of their radii. Let g_m be the

acceleration of gravity on the moon; g_e, the acceleration on the earth; m the mass of the moon, and M the mass of the earth; r'' the radius of the moon, R^1 the radius of the earth, then

$$g_m : g_e :: m/(r'')^2 : M/(R^1)^2 \text{ or } g_m = g_e \frac{m}{(r'')^2}$$

when the mass and radius of the moon are expressed in terms of the mass and radius of the earth both as unity, in which case $m = 1/80$, and $r'' = 0.273$. The square of 0.273 is 0.0747, hence

$$g_m = 9.806 \frac{0.0125}{0.0747} = 1.64 \text{ meters.}$$

The superficial attraction of the moon is about one-sixth that of the earth. A body on the surface of the moon falls 2.69 feet during the first second, as compared with 16.1 feet on the earth's surface.

Problem 37.

How much does the moon fall toward the earth in a second? Is the attraction of the earth for the moon greater or less than the attraction of the sun for the moon?

Solution.—1. In the case of any planet moving in a circular orbit the acceleration is (equation 10, problem 36)

$$a = 4\pi^3 r / T^2$$

In this case, r, the radius of the moon's orbit is 386,244,000 meters (240,000 miles), T, time of the moon's roation is 27.3 days or 27.3 × 860,000 seconds; therefore in meters

$$a = \frac{4 \times 3.1416^3 \times 386{,}244{,}000}{(27.3 \times 860{,}000)^2} = 0.00274 \text{ meters.}$$

The distance the moon falls toward the earth in 1 second is one-half of this, or 0.00137 meter, about 0.0539 inch. The moon while traveling 0.64 mile (40,550 inches) in its orbit falls toward the earth about one-twentieth of an inch.

Verification: Since the force exerted by the attraction of the earth on a given mass is proportional to the acceleration produced in the mass, it follows from Newton's law that if R' is the radius of the earth, r' the radius of the moon's orbit, g_e the acceleration of gravity at the surface of the earth, and a'' the acceleration produced by the earth at the distance of the moon, then

$$a'' : g_e :: (R')^2 : (r')^2 \text{ or } a'' = g_e (R')^2/(r')^2$$

Expressed in feet per second per second $g=32.2$; $R'=4{,}000$ miles, $r'=240{,}000$ miles, we obtain

$a''=\dfrac{32.2\times(4{,}000)^2}{240{,}000^2}=32.2\times 1/3600=0.00894$ foot per second per second.

One-half of this is about one-twentieth of an inch. The agreement is close. (Watson's Physics, p. 122.)

2. If E is the attraction of the earth on the moon, and S the attraction of the sun on the moon, M the mass of the earth, M' the mass of the sun, r' the radius of the moon's orbit, and r the distance of the sun from the moon, then

$$E:S::\frac{M}{(r')^2}:\frac{M'}{r^2} \text{ or } S=E\times M'/r^2$$

when the mass of the earth and distance from the moon are considered unity. In this case the mass of the sun and its distance from the moon must be expressed in terms of M and r'. The mass of the sun is 330,000 times that of the earth, and its distance is about 389 times that of the earth from the moon, therefore

$$S=E\times 330{,}000/389^2=E\times 2.18$$

The sun's attraction for the moon is more than double that of the earth.

Problem 38.

How much does the attraction of the moon diminish the weight of a cubic meter of dry air (under standard conditions) at the earth's surface when the moon is in position to exert its maximum lifting force, i. e., when directly overhead?

Solution.— The lifting force directly under the moon, expressed as a fraction of the earth's gravity, may be ascertained as follows (see fig. 5) page 344:

The distance from the moon to the center of the earth, M to E, is 240,000 miles; the earth's radius ES in round numbers is 4,000 miles; therefore if the radius of the earth be unity the moon's distance is 60. Also, if the mass of the earth be unity, the mass of the moon is one-eightieth.

The attractive power of the moon on a particle at the surface of the earth at S must be a little greater than its attraction on a particle at the center E, and the difference between the two must represent the lifting power of the moon on any mass at S. By the law of

Newton the attractive power of the moon on a particle at E, in terms of the attractive force of the earth is given by the following proportion:

$$g_m : r_e :: \frac{m}{r^2} : \frac{M}{R^2} \text{ or } g_m = g_e \times m/r^2$$

when M and R are unity. Substituting the proper values of m and r, in this case one-eightieth, and 60 (i. e., E to m) gives

$$g_m = g_e \times \frac{1/80}{60^2} = 0.0000034723 g_e$$

And in like manner the attractive force of the moon on a particle at S is

$$g_m = g_e \times \frac{1/80}{59^2} = 0.0000035910 g_e$$

The difference between the attractive forces at E and S is $(0.0000035910 - 0.0000034723)g_e$ or $0.0000001187 g_e$. This is equal to $\frac{1}{8,424,000} g_e$. Therefore a body weighing 1 gram at the surface of the earth will lose in weight under the vertical moon $\frac{1}{8,424,000}$ of a gram. A cubic meter of dry air weighs 1,293.05 grams, and will lose in consequence of the moon's attraction about 0.00015 gram, or an excessively small portion of its weight. A pound avoirdupoise (7,000 grains) will lose less than one-thousandth of a grain (0.0008 grain). (Young's Astronomy, p. 281.)

It is thus demonstrated that the power of the moon on the atmosphere is extremely small. It has been found also that the warming effect of full lunar radiation upon a thermometer coated with lampblack is one six-thousandth of a degree Centigrade; that the light of the moon, which, of course, is only reflected sunlight, is about one six-millionth part of sunlight. As the moon can only influence the earth's atmosphere by its attractive power, by its light, or by the amount of heat radiated, it would seem impossible for the moon to have an appreciable effect on the weather.

Problem 39.

A body lying on a smooth, frictionless, horizontal plane on the earth's surface is at rest relative to the surface. What are the forces which, on the rotating earth, maintain it in equilibrium?

Solution.—1. A planet revolving around a center is kept in its circular path by the gravitational attraction of the central body. The

pull toward the center is called "centripital force." As the planet maintains its distance from the central body, the centripital force must be exactly balanced by the tendency of the body to continue forward in a straight line, which is due to its inertia. The tendency away from the central body is called "centrifugal force." We might conceive the revolving body to be kept in its circular path by some other force than gravitation, as, for instance, by the pressure of a spring acting on the side opposite the center of the orbit, and the pressure against this spring would measure the centrifugal force. It will be evident that the force exerted against the spring will be greater for a dense than for a light body, and is, in fact, proportional to the mass of the body. Therefore the complete expression for the centrifugal force, since it must equal the acceleration toward the center multiplied by the mass, becomes, by equation (9), problem 35

$$\text{Centrifugal force} = mrw^2. \tag{1}$$

Let us now consider only the motion of the earth on its axis. (See fig. 6, p. 344). Upon a smooth, horizontal plane AB, at latitude, ϕ a body is placed whose mass is m. It will remain at rest with reference to the earth's surface. In reality it is under the influence of a centrifugal force mrw^2 due to the angular speed of rotation at latitude, ϕ, where the radius is r, and the gravitational attraction of the earth, g, which gives the body its weight mg (Physics, Watson, p. 85).

The centrifugal force mb may be resolved into two components, one of which, ma, is perpendicular to the horizontal plane, and the other, mB, is parallel to it. By geometry the angle $amb = OpB = Pmp$, which is the angular altitude of the pole, or the latitude of the point m. The components evidently are:

$$ma = mrw^2 \cos \phi \text{ and } mB = mrw^2 \sin \phi.$$

2. The body, m, is under the influence of a horizontal force $mrw^2 \sin \phi$. If the earth were a rigid sphere in rotation, this component would not be counteracted by any other force, and all bodies on the earth's surface would move toward the equator; but since the earth is plastic, an accumulation of matter has occurred about the equator, so that the globe has the form of an oblate sphere. Its surface is an inclined plane from the equator to the pole of such slope that the tendency of a body on the surface to fall toward the pole is exactly equal to the horizontal component mB directed toward the

equator. The horizontal line AB is not perpendicular to the radius Om, but to a line making a small angle γ with the radius. Designating gravity by A, the force compensating mB is evidently the component $mA = A \sin \gamma$.

$$A \sin \gamma = mrw^2 \sin \phi. \tag{2}$$

The amount of this force in any latitude is readily calculated. Let m the mass of the body be unity (1 gram in the *c. g. s.* system); r, the radius of the earth at the corresponding latitude; for latitude 45° approximately 4,504,536 meters. The angular velocity w of a point on the surface of the earth is $2\pi/T$, where T is the length of the siderial day. It is the same at all latitudes, namely

$$w = \frac{2 \times 3.1416}{86164} = 0.00007292 \text{ (in radians).}$$

The sine of 45° is 0.70711, hence $mrw^2 \sin \phi$ is equal to

$$1 \times 4{,}504{,}536 \times 0.00007292^2 \times 0.70711 = 0.00185$$

meters per second per second.

The effect of this force is to cause a heaping up of the air in the equatorial regions, that is the atmosphere itself must have a more pronounced spheroidal form than the solid earth.

3. The component $ma = mrw^2 \cos \phi$, representing the centrifugal force, opposes the component of gravity, $A \cos \gamma$, and the latter must be in excess, since the body m presses upon the plane with a force proportional to its weight mg. This component, however, has the effect of diminishing the weight of a body by a small amount; since it is a function of the latitude and the corresponding length of the radius, it is greatest when $\cos \phi$ and r are greatest—that is, at the equator. A body at the equator weighs less than a body at the poles.

The effect of this upon the mercurial column of a barometer is as follows: At the equator the pressure of the mercurial column is less than at the parallel of 45°, and hence the height which counterpoises the atmospheric pressure is greater than it would be at latitude 45° and so it must be diminished to reduce it to standard conditions. At the poles the reverse is the case. The correction is about -2.02 millimeters at the equator and $+2.02$ millimeters at the poles.

Since pressure is measured by the product of the mass into the acceleration, the body at m whose mass is m presses upon the surface with a force mg. From figure 6, it is evident that

$$mg = A \cos \gamma - mrw^2 \cos \phi. \tag{3}$$

where r is the length of the radius at latitude 45°. At any other latitude the length of the radius becomes, $r = R \cos \phi$, which substituted in (3) gives

$$mg = A \cos \gamma - mw^2 R \cos^2 \phi, \text{ or } g = \frac{A \cos \gamma}{m} - w^2 R \cos^2 \phi. \tag{4}$$

4. Usually, however, the acceleration of gravity at various latitudes is determined by pendulum observations, leading to an empirical formula. According to Helmert (Watson's Physics, p. 134) the value of g at a place in latitude ϕ and at sea level is given by the equation

$$g = 9.77989\ (1 + 0.0052 \sin^2 \phi) \text{ meters per second}^2: \tag{5}$$

or, the exponent 2 is read per second per second.

Since the sine of 45° = 0.70711, therefore for latitude 45° g_{45} becomes

$$9.77989\left(1 + \frac{0.0052}{2}\right) = 9.77989 + \frac{0.051}{2} = 9.806 \text{ meters per second}^2.$$

By a simple transformation of equation (5)

$$g_\phi = 9.77989 + 9.77989 \times 0.0052 \sin^2 \phi.$$

For $\sin^2 \phi$ substitute its value (by trigonometry) $\frac{1}{2}(1 - \cos 2\phi)$, giving

$$g_\phi = 9.77989 + \frac{9.77989 \times 0.0052}{2}(1 - \cos 2\phi)$$

Reducing we get

$$g_\phi = \left(9.77989 + \frac{0.051}{2}\right) - \frac{0.051}{2} \cos 2\phi.$$

Since the first part on the right-hand side is g at latitude 45° we have

$$g_\phi = g_{45} - 0.0255 \cos 2\phi = g_{45}(1 - \frac{0.0255}{g_{45}} \cos 2\phi).$$

Finally

$$g_\phi = g_{45}(1 - 0.0026 \cos 2\phi). \qquad (6)$$

This expression, which gives the value of the acceleration of gravity as a function of the cosine of the latitude is generally employed in meteorologic work. In the Smithsonian Tables the value 0.002662 as determined by Prof. Harkness from astronomic data is employed. (Sprung, Lehrbuch der Meteorologie, p. 10.)

PROBLEM 39A.

Gravity diminished by the centrifugal force at the earth's surface or apparent gravity on the earth's surface at latitude 45° is 9.806 meters per second per second, what is it without centrifugal force and as acting on bodies outside the atmosphere? (Abbe.)

PROBLEM 40.

The average height of the mercurial column at latitude 45° and sea level with a temperature of 0°C. is 760 millimeters. What height of the mercurial column will represent the same pressure at the equator, at the pole, on a mountain top at an altitude of 5 kilometers?

Solution.—1. The pressure of the atmosphere is usually expressed by the length of the mercurial column in inches or millimeters, but two other methods of measuring pressure are also employed in meteorology. First, the pressure may be expressed in units of weight, in kilograms per square meter, or grams per square centimeter. Thus a barometric height of 760 millimeters is equivalent to a pressure of 1033.3 grams per square centimeter, or the product of the height of the column 76 centimeters by the specific gravity of mercury, 13.596.

Second, the pressure may be expressed as a unit of force. In the c. g. s. system the unit of force, the dyne, is that force which will cause an acceleration of 1 centimeter per second per second in a mass of 1 gram. The attraction of gravity on the surface of the earth, however, produces in a mass of 1 gram an acceleration, g, which is equal to 980.6 centimeters per second per second at latitude 45° and sea level. Weight (expressed as a unit of force) is equal to the product of the mass in grams into the acceleration, or $W = mg$. At latitude 45° a gram presses upon the surface upon which it rests with a force of 980.6 dynes, but since gravity is not the same at all latitudes, the weight of a gram also varies with latitude.

2. The pressure of the mercurial column in units of force, P_0, is equal to the product of its mass (height × specific gravity of mercury) into the acceleration of gravity at the place. At latitude 45°

and sea level where gravity is g_o and the normal height of the barometer B_n, and the density of mercury D_m, we have

$$P_o = g_o D_m B_n$$

At any other latitude, ϕ, where the attraction of gravity is g_ϕ, the pressure, P, becomes

$$P = g_\phi D_m B_o$$

B_o being the barometric reading at latitude ϕ, and sea level corrected for temperature of scale only.

If the height of the mercury B_o at latitude ϕ, is to express the same pressure as the normal height B_n at latitude 45°, the two expressions must be equal, or

$$g_o D_m B_n = g_\phi D_m B_o \text{ or } B_n = B_o \frac{g_\phi}{g_o} \text{ and } B_o = B_n \frac{g_o}{g_\phi} \qquad (1)$$

Using equation (6) of problem 39 to determine the value of g_ϕ at the equator and at the pole, which may easily be done without a table, since cos 0° is 1, and cos $2 \times 90°$ is -1, we find,

At the pole $g = 983.21$ centimeters per second².

At the equator $g = 977.99$ centimeters per second².

Therefore at the pole

$$B_o = 76 \times \frac{980.6}{983.21} = 757.98$$

and at the equator

$$B_o = 76 \times \frac{980.6}{977.99} = 762.02$$

A barometric reading of 757.98 millimeters at the pole and one of 762.02 millimeters at the equator represent the same pressure in standard c. g. s. units as 760 millimeters at latitude 45°. The correction of a mercurial barometer for gravity at the pole is +2.02 millimeters and at the equator −2.02 millimeters. (See Smithsonian Meteorological Tables, 1907, Table 13.)

By substituting the value of g_ϕ given in equation (6), problem 39, the formula becomes

$$B_n = B_{45}(1 - 0.002662 \cos 2\phi) \qquad (2)$$

3. If the barometer is observed on the summit of a mountain at an altitude of h meters above sea level, then, since gravity varies inversely

as the square of the distance from the center of the earth $(R+h)$, we have

$$g_\phi : g_{\phi h} :: (R+h)^2 : R^2 \text{ or } g_{\phi h} = g_\phi \frac{R^2}{(R+h)^2}$$

and

$$g_{\phi h} = \frac{g_\phi}{1+\frac{2h}{R}} \tag{3}$$

in which the very small quantity $\frac{h^2}{R^2}$ in the development of $(R+h)^2$ is neglected. The value of the coefficient of h or $2/R$ is 0.000000314. ($R = 6370191$ meters.)

This value is slightly modified because the mass of the earth lying between the elevated station and sea level is additional attractive matter which increases g and thus slightly lessens the decrease with altitude above the mountain. Poisson's correction has been adopted by the International Bureau of Weights and Measures, which makes the coefficient of h $1.25/R$ instead of $2/R$, therefore equation (3) becomes

$$g_{\phi h} = g_\phi\left(\frac{1}{1+.000000196h}\right) \tag{4}$$

Carrying out the division and neglecting terms in the higher powers of $.000000196h$ gives

$$g_{\phi h} = g_\phi(1-.000000196h) \tag{5}$$

NOTE.—Recent studies by Hayford and Bowie, of the Coast and Geodetic Survey, and by Helmert, of Berlin, have altered these conclusions by showing that the earth is in isostatic equilibrium.

At an altitude of 5 kilometers = 5,000 meters at latitude 45°, $g_{\phi h}$ becomes 980.6 $(1-.000000196\times 5{,}000) = 979.6$. Then by equation (1) the barometric height at an altitude of 5 kilometers which expresses the same force as 760 millimeters at sea level is

$$B = 76 \times \frac{980.6}{979.6} = 760.775 \text{ millimeters}$$

What would be the gravity correction for altitude on Mount Everest, altitude 29,000 feet, or 8,842 meters, latitude 27° 58′? On Pikes Peak, Colo., altitude 14,134 feet, latitude 38° 50′?

PROBLEM 41.

Deduce the final correction for the mercurial column of the barometer, combining the corrections for the temperature of the mercury and the scale and the gravity corrections for latitude and altitude.

Solution.—See problems 8, 39, and 40. From problem 8,

$$B_o = B(1 - \frac{(m-n)t}{1+mt}) \tag{1}$$

By equation (6), problem 39,

$$g_\phi = g_{45}(1 - 0.002662 \cos 2_\phi) \tag{2}$$

Substituting for g_ϕ its value from equation (5) problem 40, i. e.

$$g_\phi = \frac{g_{\phi h}}{(1 - .000000196h)}$$

giving

$$g_{\phi h} = g_{45}(1 - .002662 \cos 2\phi)(1 - .000000196h) \tag{3}$$

By equation (1), problem 40,

$$B_n = \frac{B_o g_{\phi h}}{g_{45}}$$

Substituting for $g_{\phi h}$ its value from (3)

$$B_n = B_o(1 - .002662 \cos 2\phi)(1 - .000000196h)$$

where B_o is the barometer corrected for temperature only, that is the B_o of expression (1). Substituting, we have for the final correction in the metric system:

$$B_n = B(1 - \frac{(m-n)t}{1+mt})(1 - .002662 \cos 2\phi)(1 - .000000196h) \tag{4}$$

B is the observed reading of the barometer. This may be expressed in the form

$$B_n = B(1 - .000163t)(1 - .002662 \cos 2\phi)(1 - .000000196h) \tag{5}$$

A useful exercise for the student will be to express the same formula in the English system. (See the note to problem 8.)

Problem 42.

Calculate the possible velocities of the wind for various gradients, excluding the effects of friction or viscosity.

Solution.—1. From the ratio of the specific gravity of mercury and air, it is evident that at sea level under normal conditions an excess of pressure at a place 1 millimeter above another not far distant will correspond to a difference in the air column of $13.596/1.293 =$ 10,515 millimeters or 10.5 meters. Therefore, when a place A has a pressure of B millimeters, and another place C at a known distance from A has a pressure $B+dB$ millimeters, then at the last place the pressure B would be found at a height $h=s.dB$, where s represents the ratio of the specific gravity of mercury to the specific gravity of air. Therefore $h=10.5\ dB$.

2. The velocity with which a mass of air reaches the foot of an inclined plane, neglecting friction and viscosity, is the same as if the fall took place vertically downward and is $v=\sqrt{2gh}$. Substituting for g its value 9.8 meters per second per second, and for h the value $10.5\ dB$ we have the velocity acquired

$$v=\sqrt{2\times 9.8\times 10.5dB}=14.36\sqrt{dB} \qquad (1)$$

3. By equation 1, problem 12, at any other temperature $t°$ and pressure b, the density of air would become

$$\frac{1.293b}{(1+at)0.76}$$

therefore s, the ratio of the specific gravity of mercury and air becomes

$$s=\frac{13.596\times 0.76\times(1+at)}{1.293b}=\frac{7991(1+at)}{b}$$

Replacing a by its value 1/273 in the last expression,

$$s=\frac{7991\,\frac{273+t}{273}}{b}$$

Calling $(273+t)$ the absolute temperature T and $7991/273=29.3$ the gas constant R, (see problem 11), we have

$$s=RT/b \text{ for 1 millimeter.}$$

Therefore

$$h=\frac{RT}{b}dB$$

The possible velocity becomes

$$v = \sqrt{2 \times 9.8 \times 29.3\, TdB} = 24\sqrt{\frac{T.dB}{b}} \tag{2}$$

(Hann's Lehrbuch, 1st ed. p. 416.)

4. If the difference in pressure between two places is known and the distance between them, then the gradient or inclination of the barometric slope is readily found. It is evidently the height h corresponding to the difference in pressure divided by the distance between the stations D or $10.5\ dB/D$. If a suitable diagram is drawn it will be found that this expression gives the tangent of the angle of slope, a.

Examples: The January mean barometric pressure at Eastbourne, England, is 761.9 millimeters; at Butt of Lewis in the north of Scotland, it is 753.4 millimeters. The two places are 821 kilometers apart. The difference of pressure is 8.5 millimeters. Inclination of the isobaric slope $10.5 \times 8.5/821{,}000 = \tan.\ 22''$ of arc, or a fall of 10.9 centimeters in a kilometer. Possible velocity $14.36\sqrt{8.5} = 41.6$ meters per second (93 miles an hour).

During the hurricane of January 24, 1868, at Edinburgh, a pressure of 750.7 millimeters was reported at Thirlestane Castle, and 743.8 millimeters at Edinburgh. The distance between the places is 32.2 kilometers. The angle of slope was $10.5 \times 6.9/32{,}200 = \tan a =$ an angle of 7.8′ or about 2½ meters in a kilometer. Possible velocity $14.36\sqrt{6.9} = 37.8$ meters per second (84 miles an hour).

By means of the formula $h = RT.dB/b$ the student should compute a table giving the height of a column of pure dry air equal to 1 millimeter of barometric pressure, for different temperatures and pressures. He may compare his results with Table VI in Ferrel's Treatise on Winds, page 478.

By means of the formula $v = 24\sqrt{T.dBb}$ compute a table of possible velocities for differences of pressures of 1 to 25 millimeters at 0° C.

Problem 43.

Compute trigonometrical formulas for determining the heights of clouds in the following cases: Cloud vertically over base line and between stations; cloud over base line but beyond a station; cloud not over base line.

Solution.—1. Cloud over base line between stations (fig. 7):

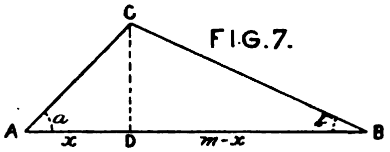
The known quantities are $AB = m$, and the angular altitudes of the point C in the cloud from the ends of the base line, or the angles a and b. By trigonometry

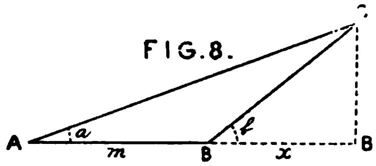
$CD = x\ tan\ a = (m-x)\ \tan b$. Therefore $x \tan a = (m-x) \tan b$

$$x = \frac{m \tan b}{\tan a + \tan b} = \frac{m \sin b \cos a}{\sin (a+b)}$$

Then

$$CD = \tan a \frac{m \sin b \cos a}{\sin (a+b)} = \frac{m \sin a \sin b}{\sin (a+b)}$$





2. Cloud passing beyond one station (fig. 8):

$CD = x \tan b = (m+x) \tan a$. Therefore $x \tan b = (m+x) \tan a$

$$x = \frac{m \tan a}{\tan b - \tan a} = \frac{m \sin a \cos b}{\sin (b-a)}$$

And

$$CD = \tan b \frac{m \sin a \cos b}{\sin (b-a)} = \frac{m \sin a \sin b}{\sin (b-a)}$$

3. Cloud not over base line (fig. 9). In this case the azimuths of the point C as seen from the end of the base line AB must also be known, that is, the angles y and y'. The solution will be indicated and may be completed by the student.

$$s = \frac{AB \sin y'}{\sin (y+y')}$$

$$p = \frac{AB \sin y}{\sin (y+y')}$$

Then

$$CD = \tan a \frac{AB \sin y'}{\sin (y+y')}$$

or

$$CD = \tan b \frac{AB \sin y}{\sin (y+y')}$$

Consult Abbe's Treatise on Meteorological Apparatus and Methods, pages 310 to 336. Also Bigelow's Cloud Report, chapter 2.

PROBLEM 44.

Explain the method of calculating cloud velocities from nephoscope observations.

Solution.—Upon the mirror of the nephoscope a scale graduated to millimeters is engraved, and above it is fixed a sighting knob. The image of the cloud is viewed in the mirror, and the number of graduations traversed by the image in a given number of seconds is the apparent velocity of the cloud. If the height of the cloud is known, or if, as may be done with a fair degree of accuracy, the cloud is assumed to have the average altitude of its class, then the actual velocity may be found.

By geometry from the similarity of triangles (see fig. 10):

$$FB : EC :: AF : ED :: PB : PC \therefore ED = AF\frac{PC}{PB} \qquad (1)$$

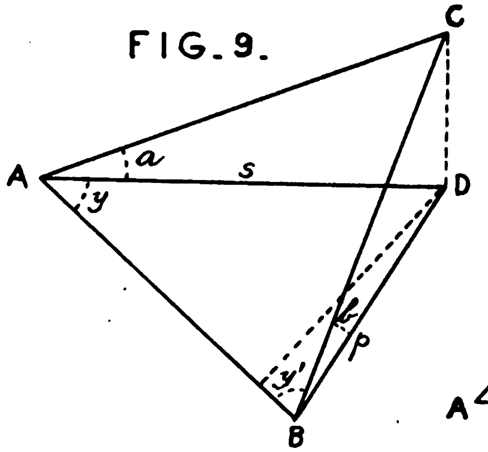


FIG. 9.

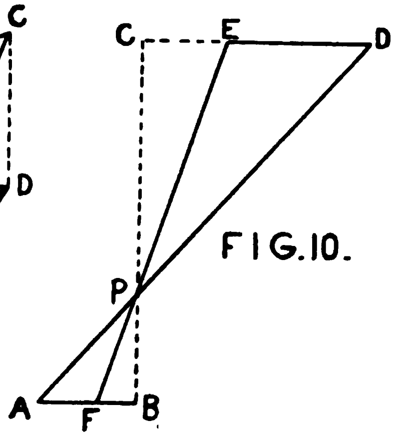


FIG. 10.

Let $S = ED$, be the space traversed by the cloud in the sky in t seconds; $m = AF$, be the number of millimeters on the graduated scale traversed by the cloud image in t seconds; $H = PC$, be the height of the cloud above the sighting point P; and $h = PB$, be the height of the sighting point above the mirror, usually fixed at 120 millimeters.

From (1):

$$S = m\frac{H}{120}$$

Divide both sides by the time t, remembering that $S/t = V$, the velocity of the cloud, then

$$\frac{S}{t} = V = \frac{m}{t} \cdot \frac{H}{120} \qquad (2)$$

If the velocity is to be expressed in miles or kilometers per hour, the time t must be expressed in fractions of an hour, or t seconds = $t/3600$ hours, giving

$$V = \frac{m\,3600}{t} \cdot \frac{H}{120} = \frac{30mH}{t} \qquad (3)$$

If $H=1$ mile, and $t=30$ seconds, then $V=m$, or the velocity in miles per hour is equal to the number of millimeters of the scale traversed by the cloud in 30 seconds. (Bigelow's Cloud Report, pp. 30–31.)*

PROBLEM 45.

Having given the monthly and annual mean temperatures of a place in centigrade degrees, find a concise mathematical formula which will give the mean temperature for any month as a trigonometrical function of an angle.

Solution.—1. The monthly mean temperatures at Atlanta, Ga., for the period 1866–1911, in centigrade degrees, with the departures are as follows:

Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
6.0 −10.1	7.4 −8.7	11.5 −4.6	15.9 −0.2	20.6 +4.5	24.3 +8.2	25.9 +9.8	25.1 +9.0	21.2 +5.1	16.4 +0.3	11.0 −5.1	7.0 −9.1	16.1 ......

Let the line AD, figure 11, be divided into 12 equal parts, each 30° in length, representing the 12 months of the year. At the points a, b, c, etc., erect lines perpendicular to AD proportional in length to the departures of the monthly means from the annual mean at Atlanta. Draw a smooth curve through the terminal points, and we have the sinusoid $A'BCD'$ in which the abscissas correspond to angles and the ordinates to their sines.

The equation of this curve is readily obtained. If we take the year to commence at the date when the ascending temperature curve crosses the normal for the year, which is April 6 at Atlanta, and consider that the mean amplitude of the departures is $(10.1+9.8)/2=10$, the equation becomes

$$t^\circ = 10 \sin x$$

where x advances 30° for each month, and for April 6, $x=0°$.

* Two nephoscopic observations on a moving vessel give the data from which absolute altitude and velocity of the cloud may be computed.

However, since we begin the year with January the value of the variable angle x should be $0°$ for January. Since the lowest temperature for the year occurs about the middle of January, the sine of the variable angle for January must reach its greatest negative value, or -1, corresponding to an angle of $270°$. The equation of the curve is obtained then by adding the constant angle $270°$ to the variable angle x, and we have

$$t° = 16.1 + 10 \sin (270° + x) \tag{1}$$

This simple equation gives a close approximation to the monthly mean temperatures at Atlanta, the errors of the computed means ranging from 0 for February to 0.5° for June.

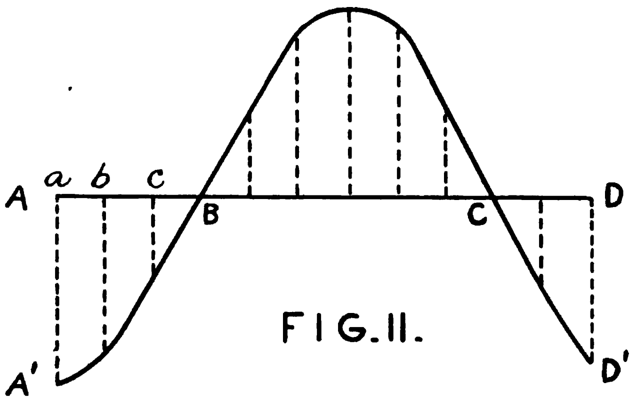


FIG. 11.

Greater accuracy may be obtained by adding to equation (1) another term, according to the general formula

$$t° = a_0 + a_1 \sin (A_1 + x) + a_2 \sin (A_2 + 2x) + a_3 \sin (A_3 + 3x) \text{ etc.,}$$

but the form of the equation is not convenient for rapid computation.

2. A more accurate equation may be determined from the development of the sine of the sum of two angles according to the well-known formula,

$$a \sin (A + x) = a \sin A \cos x + a \cos A \sin x = p \cos x + q \sin x$$

where $p = a \sin A$, and $q = a \cos A$; from which $p/q = \sin A / \cos A = \tan A$ and $p / \sin A$ or $q / \cos A = a$. The equation thus developed has the form

$$a_0 + p \cos x + q \sin x + p_1 \cos 2x + q_1 \sin 2x + \text{etc.}$$

The constants p and q are found by the method of least squares (see E. Schmid, Lehrbuch der Met., 1860, p. 8 et seq.). Representing the equidistant observations, in this case the successive monthly mean temperatures, by u_0, u_1, u_2, u_3, to u_{n-1}, then

$$p_0=a_0=(u_0+u_1+u_2+ \quad \dots\dots \quad u_{n-1}u \div n, \text{ the arithmetical mean}$$
$$p_1=(u_0+u_1\cos x+u_2\cos 2x+ \quad \dots \quad u_{n-1}\cos(n-1)x)\div n/2$$
$$q_1=(u_1\sin x+u_2\sin 2x+ \quad \dots\dots \quad u_{n-1}\sin(n-1)x)\div n/2$$
$$p_2=(u_0+u_1\cos 2x+ \quad \dots\dots \quad u_{n-1}\cos(n-1)2x)\div n/2$$
$$q_2=(u_1\sin 2x_2\sin 4x+ \quad \dots\dots \quad u_{n-1}\sin(n-1)2x)\div n/2$$

The actual computation of the constants is very easy, and the work may be arranged in the following compact form:

Computation of the annual march of temperature at Atlanta, Ga.

Jan. 6.0°	Feb. 7.4°	Mar. 11.5°	Apr. 15.9	May. 20.6	June. 24.3°	July. 25.9	Aug. 25.1	Sept. 21.2	Oct. 16.4	Nov. 11.0	Dec. 7.0
0 −	+30 −	+60 −	+90 −	−60 +	−30 +	0 +	+60 +	−60 −	−180 −	−60 −	+60 +
+ 6.0 −25.9	+ 7.4 −25.1	+11.5 −21.2	+15.9 −16.4	−20.6 +11.0	−24.3 + 7.0	+ 6.0 +25.9	+ 7.4 +25.1	−11.5 −21.2	−15.9 −16.4	−20.6 −11.0	+24.3 + 7.0
−19.9 −30.3	−17.7 ∓17.3	− 9.7 ∓ 9.6	− 0.5 − 0.2	∓9.6	∓17.3	+31.9 −32.3	+32.5 ±31.3	∓32.7 −31.6	−32.3	−31.6	±31.3 ....
− 9.6	−35.0	−19.3	−0.09	....	....	− 0.4	+63.8	−64.3	....	+65.2	....
−59.8	....	....	−0.79	....	....	−0.25	= −0.5 cos 60		....	−62.9	....
....	− 0.4	− 0.1	....	....	....	−0.65	....	....	....	+ 2.3 sin 60 1.99	

$$p_1=-\frac{59.8}{6}=-10 \qquad\qquad p_2=-\frac{0.65}{6}=-0.11$$
$$q_1=-\frac{0.79}{6}=-0.13 \qquad\qquad q_2=\frac{1.99}{6}=+0.33$$

Log p_1 = 1.00000
Log q_1 = 9.11394 A_1

Log (p_1/q_1) = 1.88606 = log tan 89° 15′

Log p_1 = 1.00000 } sin and cos negative, angle
Log sin A = 9.99996 } in 3d quad.

Log a_1 = 1.00004 269.25°
a_1 = 10.

Log p_2 = 9.04139
Log q_2 = 9.51851 A_2

Log (p_2/q_2) = 9.52288 Log tan 73° 18′

Log p_2 = 9.04139
Log sin A_2 9.98129

Log a_2 = 9.06010 286.7°
a_2 = +0.11

Hence the equation for the annual march of temperature at Atlanta has the form

$$16.1+10\sin(269.25°+x)+0.11\sin(286.7°+2x) \qquad (2)$$

or,

$$16.1-10\cos x-0.13\sin x-0.11\cos 2x+0.33\sin 2x.$$

3. The computation of the monthly means by this formula is conveniently arranged as follows:

I Term.

Angles	−89° 15′	−59° 15′	−29° 15′	+0.45′	+30° 45′	+60° 45′
Log sins Log a_1	9.99996 1.00000	9.93420 1.00000	9.68897 1.00000	8.11693 1.00000	9.70867 1.00000	9.94076 1.00000
	0.99996 10.0	0.93420 8.59	0.68897 4.89	9.11693 0.131	0.70867 5.11	0.94076 8.72

90° 45′=89° 15′; angles repeat.

II Term.

Angles	−73° 18′	−13° 18′	46° 42′
Log. sins Log. a_2	9.98129 9.06010	9.36182 9.06010	9.86200 9.06010
	9.04139 0.11	8.42192 0.026	8.92210 0.084

Angles now repeat.

Temperatures at Atlanta.

I II	−10.0 − 0.11	−8.59 −0.03	−4.89 +0.08	+0.13 +0.11	+5.11 +0.03	+8.72 −0.08	+10.0 − 0.11	+8.59 −0.03	+4.89 +0.08	−0.13 +0.11	−5.11 +0.03	− 8.72 − 0.08
 A_0	−10.1 16.1	−8.6 16.1	−4.8 16.1	+0.24 16.1	+5.1 16.1	+8.6 16.1	+ 9.9 16.1	+8.6 16.1	+5.0 16.1	−0.02 16.1	−5.1 16.1	− 8.8 16.1
Computed Observed Errors	6.0 6.0 0	7.5 7.4 +0.1	11.3 11.5 −0.2	16.3 15.9 +0.4	21.2 20.6 +0.6	24.7 24.3 +0.4	26.0 25.9 + 0.1	24.7 25.1 −0.4	21.1 21.2 −0.1	16.1 16.4 −0.3	11.0 11.0 0	7.3 7.0 + 0.3

Note for the student.—In order to understand the abbreviated computation, the value for p_1 and q_1 should be worked out in full, for example:

$$p_1 = 6.0 + 7.4 \cos 30° + 11.5 \cos 60° + 15.9 \cos 90° + 20.6 \underset{(-\cos 60)}{\cos 120°}$$

$$+ 24.3 \underset{(-\cos 30)}{\cos 150°} + 25.9 \underset{(=-1)}{\cos 180} + 25.1 \underset{(-\cos 30)}{\cos 210°} + 21.2 \underset{(-\cos 60)}{\cos 240}$$

$$+ 16.4 \underset{(-\cos 90)}{\cos 270} + 11.0 \underset{(+\cos 60)}{\cos 300} + 7.0 \underset{(+\cos 30)}{\cos 330}.$$

Now collect the appropriate terms together, and the method of computation will readily be seen.

(Hann Lehrbuch der Meteorologie, 1st ed., pp. 725–731.)

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BULLETIN

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(XVIII.) THE WOLF-WOLFER SYSTEM OF RELATIVE SUN-SPOT NUMBERS FOR THE YEARS 1901–1912.

By A. WOLFER.

(A) The recent analysis by Prof. Humphreys of the influence on terrestrial temperatures of any delicate volcanic dust that may exist in that portion of our upper atmosphere known as the stratosphere, makes it important to eliminate this influence from the results of pyrheliometric observations and thus leave the way clear for the study of solar radiation proper. We now reprint the remarks and explanations offered by us in the Monthly Weather Reviews of November, 1901, and particularly April, 1902, where we published the tables and diagrams constituting the first authoritative issue of Prof. Wolfer's revision of the original numbers of Prof. Wolf for the period 1749–1900. We are also allowed by Prof. Wolfer to publish the "original observed" and the "final smoothed numbers" for the next succeeding complete sun-spot period (1901–1912), as the continuation up to the present date of his tables in the Monthly Weather Review for April, 1902.

The remarkable influence now known to be exerted by the slight particles of terrestrial volcanic dust on our observed insolation may eventually make it important to publish in detail the original crude sun-spot records, so that we may avoid attributing to solar conditions those variations in terrestrial temperatures that really originate on our own earth or in its atmosphere. We must understand our terrestrial phenomena before we conclude it necessary to invoke the sun, moon, and stars.—C. A.

[Extract from Montnly Weather Review, November, 1901, page 505.]

(B) Prof. Wolf chose the mean solar day as the unit of time, and noted day by day both the number of visible groups of spots and

also the number of spots contained in each group. A combination of these two numbers gave him his "relative numbers," expressing the sun-spot activity for that particular day. He considered that the formation of a new group of spots was more important than the appearance of a new spot in an already existing group, and was led to compute his relative numbers by the formula, $r=10g+f$, where g is the number of groups visible on any day, and f the total number of spots, whether they were in the groups or isolated. That is to say, if there were eight spots so arranged as to constitute five groups (i. e., two isolated spots and three groups of two spots in each), the relative number for the day would be 58. The average of the relative numbers for each day gave the mean monthly numbers, the average of the 12 months gave the mean annual numbers; these are the numbers given in the accompanying tables.

A different method of computing sun-spot numbers was adopted by Schwabe, who was the original discoverer of the periodic frequency of sun spots. The computations of Wolf have extended back to the earliest observations, whereas Schwabe's discovery was based on his own observations, which began in the year 1826. Schwabe adopted a general period of 10 years, but Wolf has shown that the period is exactly 11.111 years.

The relative numbers of Wolf may not give an exact expression of the sun-spot activity, since they take no account of the size of the spot, and some have proposed to introduce this latter feature into the calculation. But a careful comparison of Wolf's numbers with the record of spotted areas has shown that the numbers and the areas are in general quite nearly proportional to each other. Of course, all that we want is the relative condition from month to month and year to year.

In order to make his numbers as reliable as possible, Wolf combined together the records of different observers, using very different instruments; each of these records was first reduced by him to something like what would have been given by a normal observer (himself) using a standard instrument (his 4-foot Fraunhofer refractor), whose aperture was 3 inches, and magnifying power 64.

His series of satisfactory numbers based on actual observations begins with the year 1749. Observations were, of course, on record for earlier years, but not in sufficient numbers to justify introduction into this table. In fact, many gaps exist after 1749, and can only be filled in by plausible graphic methods of interpolation. In his original table Wolf distinguishes two degrees of reliability, namely, the heavy print, representing satisfactory and complete sets of observations, and the starred (*) figures, representing a rather small number of observations eked out by means of interpolations.

The figures that he publishes in italics are simply the maxima and minima, which are italicized in order to attract attention.

Fuller details relative to this subject may be found in the Handbook of Astronomy by Wolf; the article by A. Wolfer in the Met. Zeit., 1892; the Bibliotheque universelle de Genéve, Archives des sciences physiques et naturelle, 1891, Vol. XXVI, No. 12, and especially in the annual publication known as the Astronomische Mittheilungen, which was begun by Dr. R. Wolf, and is now continued by Prof. A. Wolfer in the Vierteljahrsschrift of the Scientific Society of Zurich.

Those who compare sun-spot numbers with meteorological phenomena should always bear in mind that the spots themselves are not likely to be the causes of changes on the earth, but are rather the result of some process in the sun that affects the earth indirectly.—C. A.

(C) The reader will find the first complete and revised series of both the observed and the smoothed relative numbers in Tables 1 and 2 on pages 173 and 176 of the Monthly Weather Review, April, 1902. The significance of these numbers is stated in the following words by Prof. Wolfer on page 171:

The *smoothed relative numbers* of Table 2 present the mean course of the spot phenomena; that is to say, without the numerous secondary short-period variations that really occur in addition to the 11-year variation. Investigations into the general course of the phenomena and into other periods should therefore be based upon these "*smoothed numbers*" and not on the "*observed numbers.*" The method of formation of these numbers has been explained by Wolf, in No. XLII of his Astronomische Mittheilungen. The mean of every 12 consecutive observed monthly relative numbers is taken and every pair of two consecutive means is again united into one mean value according to the following scheme:

$1/12\ (\mathrm{I}+\mathrm{II}+\mathrm{III}\ldots+\mathrm{XII}) = n_1$, for epoch July 1.
$1/12\ (\mathrm{II}+\mathrm{III}+\mathrm{IV}\ldots+\mathrm{XIII}) = n_2$, for epoch August 1.

$1/2\ (n_1+n_2) = r$, which is the smoothed number for mid-July.

This method of smoothing is conformable to that which Wolf has used for eliminating the annual period of the variations of magnetic declination when comparing the latter with the solar spots. This consideration was not necessary for the relative numbers, but the combination of 12 months into one mean has been adopted in order to secure a uniform method of treating both phenomena. Table 2, which contains these smoothed values, has been newly computed from beginning to end and is entirely free from error.—C. A.

(D) The following note from Prof. A. Wolfer, dated Zurich, April 16, 1913, with Tables I and II, shows the present state of our knowledge of the sun-spot frequency:

"The relative sun-spot numbers previously published in the Monthly Weather Review, April, 1902, Tables 1 and 2, have not experienced any changes or additions since that time and there is no occasion for reprinting them, *in extenso*.

"I have just now completed the computation of the definitive relative sun-spot numbers for the year 1912, and in the two following tables (1) and (2) continued, I give both the observed and the smoothed numbers, respectively, for 1900–1912. I have not added any further remarks, as the method of computation is precisely the same as was stated in the Monthly Weather Review just referred to.

"The present minimum appears inclined to drag along further than I first suspected; its epoch will undoubtedly occur in the year 1913, and perhaps rather far from the beginning of that year. Notwithstanding this I have in these accompanying tabular numbers given 1912 as the natural end. I have thus extended the previously published series by still another period of 11 years. I hope to be able to send you a similar continuation of these numbers when another 11 years shall have elapsed."

TABLE I.—*Observed relative sun-spot numbers: Wolf-Wolfers system.*

[Continued from Monthly Weather Review, April, 1902, page 173.]

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Average.
1901....	0.2	2.4	4.5	0.0	10.2	5.8	0.7	1.0	0.6	3.7	3.8	0.0	2.7
1902....	5.2	0.0	12.4	0.0	2.8	1.4	0.9	2.3	7.6	16.3	10.3	1.1	5.0
1903....	8.3	17.0	13.5	26.1	14.6	16.3	27.9	28.8	11.1	38.9	44.5	45.6	24.4
1904....	31.6	24.5	37.2	43.0	39.5	41.9	50.6	58.2	30.1	54.2	38.0	54.6	42.0
1905....	54.8	85.8	56.5	39.3	48.0	49.0	73.0	58.8	55.0	78.7	107.2	55.5	63.5
1906....	45.5	31.3	64.5	55.3	57.7	63.2	103.3	47.7	56.1	17.8	38.9	64.7	53.8
1907....	76.4	108.2	60.7	52.6	43.0	40.4	49.7	54.3	85.0	65.4	61.5	47.3	62.0
1908....	39.2	33.9	28.7	57.6	40.8	48.1	39.5	90.5	86.9	32.3	45.5	39.5	48.5
1909....	56.7	46.6	66.3	32.3	36.0	22.6	35.8	23.1	38.8	58.4	55.8	54.2	43.9
1910....	26.4	31.5	21.4	8.4	22.2	12.3	14.1	11.5	26.2	38.3	4.9	5.8	18.6
1911....	3.4	9.0	7.8	16.5	9.0	2.2	3.5	4.0	4.0	2.6	4.2	2.2	5.7
1912....	0.3	0.0	4.9	4.5	4.4	4.1	3.0	0.3	9.5	4.6	1.1	6.4	3.6

TABLE II.—*Smoothed relative sun-spot numbers: Wolf-Wolfers system.*

[Continued from Monthly Weather Review, April, 1902, page 176.]

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Average.
1901....	4.8	4.4	3.9	3.2	2.8	2.8	3.0	3.1	3.3	3.6	3.3	2.8	3.4
1902....	2.6	2.7	3.1	3.9	4.7	5.0	5.2	6.0	6.8	7.9	9.5	10.6	5.7
1903....	12.3	14.6	15.8	16.9	19.3	22.5	25.4	26.6	27.9	29.6	31.4	33.5	23.0
1904....	35.5	37.7	39.7	41.1	41.5	41.6	42.9	46.4	49.8	50.5	50.7	51.3	44.1
1905....	52.5	53.5	54.6	56.6	60.5	63.4	63.1	60.4	58.5	59.5	60.6	61.6	58.7
1906....	63.4	64.2	63.8	61.3	55.9	53.5	55.1	59.6	62.7	62.4	61.7	60.1	60.3
1907....	56.9	55.0	56.4	59.6	62.6	62.8	60.5	55.9	51.4	50.3	50.4	50.6	56.0
1908....	50.5	51.6	53.2	51.9	49.9	48.9	49.3	50.5	52.6	53.1	51.9	50.6	51.2
1909....	49.4	46.4	41.6	40.7	42.2	43.3	42.6	40.7	38.2	35.4	33.8	32.8	40.6
1910....	31.5	30.1	29.1	27.7	24.7	20.6	17.6	15.7	14.2	14.0	13.8	12.8	21.0
1911....	12.0	11.2	10.0	7.6	6.0	5.9	5.6	5.1	4.6	4.0	3.3	3.2	6.5
1912....	3.2	3.0	3.1	3.4	3.4	3.4	......	......	......	......	......	......	......

(XIX) CERTAIN CHARACTERISTICS OF EASTERLY WINDS AT BLUE HILL OBSERVATORY.

By Andrew H. Palmer, A.M.

[Dated March 29, 1913.]

In a region of prevailing westerly winds like New England, easterly winds have certain characteristics wholly unlike those from any other direction. In this discussion the term "easterly winds" refers to those blowing from any point NE. to SE., inclusive. Blue Hill Observatory, 16 kilometers south of Boston, Mass., 200 meters above sea level, and 13 kilometers from the shore of the Atlantic Ocean, has a favorable exposure for the collection of wind data, as it is singularly free from local influences. Moreover, the kite flights and pilot-balloon ascensions furnish the necessary data for upper strata. Nearly all the easterly winds recorded at the observatory are the result of the barometric distribution, since topography has no effect, while the sea breezes, so common along the immediate coast, are observed here only occasionally, and then as light variable winds. The summit of the hill is apparently in the transition stratum between the easterly sea breeze and the prevailing westerly wind aloft, for on occasions when such a breeze is blowing along the shore of Boston Harbor the anemoscope at the observatory is oscillating continuously—a condition brought about by light variable winds. A well-developed sea breeze with the wind fixed in an easterly point is seldom recorded here.

The average frequency of winds from each direction, at various heights, for summer and for winter, is given in Table I. The averages at 200 meters are those derived from the observatory anemoscope records for the 20 years, 1886–1905, inclusive. Those for the other heights are determined from the wind data obtained in 53 kite flights and 8 pilot-balloon ascensions made at Blue Hill Observatory during 15 years, 1897–1911, inclusive, *at times when the surface wind was from some easterly point*. It is apparent that at all heights easterly winds are the least frequent of those from the four principal directions, both in summer and in winter. Moreover, the frequency of easterly winds decreases markedly with height, and they are relatively rare above 2,000 meters. It is possible, however, that the table exaggerates the shallow character of easterly winds somewhat, for the reason that easterly winds are frequently so light that a kite flight is impossible, and even when the wind is strong enough to lift the kite

the latter is unable to penetrate the calm transition stratum between the lower easterly indraft and the stronger westerly current aloft. The change in direction from an easterly wind at the surface to a westerly wind aloft is usually a gradual one; that is, there is no fixed plane below which the winds are easterly and above which the winds are from the opposite direction. A pilot balloon rising in an easterly wind therefore usually describes a half-spiral in space before it rises 2,000 meters from the ground. Instances in which a well-developed west wind at the ground becomes easterly aloft are not to be found in the Blue Hill kite data.

TABLE I.—*Average percentages of frequency of winds for each direction and altitude.*

SUMMER.

Altitude.	N.	NNE.	NE.	ENE.	E.	ESE.	SE.	SSE.	S.	SSW.	SW.	WSW.	W.	WNW.	NW.	NNW.
Meters.																
200	4	5	6	5	4	3	3	6	8	9	9	9	8	8	7	6
500	2	4	5	3	2	2	3	2	5	12	12	11	12	10	11	4
1,000	4	4	3	3	1	1	1	1	2	7	15	19	15	12	6	6
2,000	5	4	3	0	0	0	1	1	0	3	10	15	23	19	9	7
3,000	2	3	3	0	0	0	0	0	0	0	2	22	29	18	11	10

WINTER.

Altitude.	N.	NNE.	NE.	ENE.	E.	ESE.	SE.	SSE.	S.	SSW.	SW.	WSW.	W.	WNW.	NW.	NNW.
200	6	5	4	3	3	3	3	4	5	6	7	9	12	11	11	8
500	5	1	2	6	1	1	2	4	4	3	13	8	13	20	13	4
1,000	5	2	3	2	2	2	3	2	2	4	8	12	13	21	15	4
2,000	1	0	1	0	0	1	0	0	2	2	8	11	20	27	21	6
3,000	1	0	1	0	0	0	0	0	2	2	6	16	16	19	31	6

The winds of least frequency are also the winds of the least average velocity. However, there is no such marked difference in the velocity of easterly and westerly winds, as there is in the case of the frequency. Usually the only easterly winds of high velocity recorded on Blue Hill are the northeasterly indraughts which occur when a well-developed cyclone is central off the Middle Atlantic coast. These winds give rise to northeast storms, a climatic feature of New England, and usually result in heavy precipitation. While kite flights are usually impossible during these storms it is probable that even these currents are not more than 3,000 to 4,000 meters deep. It is believed that in general the greater the barometric depression the thicker will be the easterly indraught, and vice versa.

While winds from all directions increase in velocity with height, the westerly winds double in velocity between 200 and 3,000 meters, while easterly winds increase only about 50 per cent in velocity in that height, taking the year as a whole. The velocities of winds from all directions increase more rapidly with height in winter than in summer.

When easterly winds were blowing, and the position of Blue Hill with reference to the barometric centers was determined, the average depth of these winds in meters was found to be as follows:

	Cyclone.				Anticyclone.			
Quadrant	NE.	SE.	SW.	NW.	NE.	SE.	SW.	NW.
Depth:	*Meters.*	*Meters.*	*Meters.*	*Meters.*	*Meters.*	*Meters.*	*Meters.*	*Meters.*
Summer	1,172	1,808	1,871	550	1,477	....	430	1,700
Winter	....	....	....	....	775	....	350	750

Of the 70 kite flights in which wind directions for heights greater than 1,000 meters were obtained, 56, or 80 per cent, showed that the direction changed with height. Northerly winds most frequently showed a tendency to change in a counterclockwise direction; with southerly winds the change was usually clockwise; with easterly winds the change was in either direction. Of the 56 cases of changing direction with height, 47, or 87 per cent, of the changes were clockwise, and the remaining 9, or 16 per cent, were in the opposite direction. When the surface winds were from the southeast quadrant of the compass the average change of direction per 1,000 meters was found to be 44°, while that for winds from the northwest quadrant was but 17°, the ratio being 2.6 to 1. The nature of the change of direction with height could not be investigated further because of an insufficient number of cases.

The data here considered seem to indicate that the westerly direction of the wind at and above Blue Hill is disturbed only by the passage of barometric centers, and that the disturbances are relatively local as far as the westerly winds are concerned. The well-established principle which recognizes a direct relationship between barometric gradient and wind velocity accounts for the fact that the greater the barometric depression the deeper and stronger will be the easterly indraught in its advance. Anticyclones sometimes give rise to easterly winds in their southwestern quadrants, especially when there is a cyclone approaching from the west. Easterly winds in the vicinity of Blue Hill, therefore, may be regarded as mere surface winds caused by suction effects when cyclonic control is temporarily greater than the more general planetary influence.

(XX) FREE-AIR DATA AT MOUNT WEATHER, VA., FOR OCTOBER, NOVEMBER, DECEMBER, 1912.

By the Aerial Section, Wm. R. Blair in Charge.

[Dated March 28, 1913.]

Sixty-one free-air observations were made during this period, 59 were by means of kites and 2 by means of captive balloons. For the most part these observations were made in series extending over periods of about 30 hours each. Six series were obtained. The mean of the highest altitudes reached in these series varied from 2,900 to 3,700 meters above sea level, and the mean height reached in all ascensions was 3,065 meters.

This article is in continuation of the current publication of the data being obtained in the study of the "Diurnal variation of temperature and other meteorological elements at different levels above Mount Weather." The same plan is followed in this as was instituted in the preceding number (Vol. V, No. 4) of this Bulletin. The instrumental defect noted in the preceding article is in evidence until the end of the third series made in October, at which time the defect was discovered and remedied. Figures 24, 29, 34, 39, 44, and 51 show the free-air isotherms charted from the temperature data obtained in the six series of observations.

In the series of October 1 and 2 the velocity of the wind after midnight in the upper levels explored was not strong enough to carry the kites. After 10 a. m. of the second day, kites could not be flown at any level, and two captive balloon ascensions were made to complete the series. The instrument used with the captive balloon made no record of humidity. Unless a series continues well beyond the 24-hour period, no satisfactory 24-hour correction can be applied to the elements observed in that series. The temperatures charted in figure 25 have been corrected and smoothed in the three lower levels only. Table XI shows corrected temperatures, smoothed temperatures, and departures from the mean for the day at these three levels. The observed temperatures are charted in the three upper levels. The curves shown in figures 26, 27, and 28 show actual observations and their interpolations of humidity, wind direction and velocity, and atmospheric electric potential.

The series of October 7 and 8 continued for 24 hours only. In figures 30, 31, 32, and 33 the curves are interpolations based upon

the actual observations of temperature, humidity, wind direction and velocity, and atmospheric electric potential, respectively. It may be noted that in this as in the previous series the wind began to weaken in velocity at about midnight in the upper and at 9 a. m. in the lower levels.

A noticeable peculiarity of the October 15 and 16 series is that the inverted region (usually found in the middle levels of those explored in these series and beginning at or shortly before midnight), appears in figure 34 as a more pronounced part of an inversion layer extending throughout the series. The region of highest temperatures in this inversion is found well before midnight. The general inversion of temperature at these levels is a characteristic accompaniment of the surface pressure distribution. A slowly advancing high pressure area was central just west of the station. This series and also that of October 30 and 31 are slightly under 24 hours in length. The data shown in figures 35, 36, 37, and 38, also in figures 40, 41, 42, and 43, are therefore not corrected for the 24-hour change nor are they smoothed.

The series of November 14 and 15 continued through 34 hours. Reference to the cloud notes in connection with the tabulated data of these dates shows that in the upper levels explored the kites were flying in strato-cumulus clouds during the greater part of the series. The temperature in these clouds was well below freezing, consequently when their moisture was blown against the kites a considerable weight of frost work formed on the windward sides of the sails and woodwork, and about the wires and instrument. This accounts for the fact that the majority of the flights of the series reached heights of less than 3 kilometers. The flights were especially low when the cloud cover was most dense. In charting the diurnal variations in temperature and absolute humidity, two 24-hour periods have been taken out of this series (the first period began 10:30 a. m. and the second began 5:30 p. m., November 14, 1912). Figures 45 and 47 show corrected and smoothed temperature curves for these two 24-hour periods, respectively. Tables XII and XIV show the smoothed and corrected hourly values of the temperature, also the departures of these from the mean for the respective 24-hour periods considered. Similar values for the absolute humidity may be found in Tables XIII and XV. Figures 49 and 50 show the wind direction and velocity and the atmospheric electric potential, respectively, for the whole 34 hours.

Conditions were exceptionally good for kite flying when the series of December 6 and 7 was obtained. Ten flights of nearly uniform height were made in about 30 hours. The series is peculiar in that the warming up after midnight occurs at a lower level than usual. This is shown in figure 51, but is more apparent in figure 52. At the

1.5 kilometer, usually the level showing smallest diurnal range, the temperature maximum found at from 2 to 5:30 a. m. is decidedly the principal one. The curves shown in figures 52 and 53 have been corrected for 24-hour change and smoothed. Figure 53 shows the diurnal variation in absolute humidity. Tables XVI and XVII show the numerical values charted in figures 52 and 53, respectively. Figures 54 and 55 are based on actual observations of wind velocity and of humidity, respectively. The crosses represent observed values.

The indications of the soil thermographs became unreliable during November, so that no November mean can be shown for the lower level and no December data for either level. Table XVIII shows, as far as possible, the mean hourly temperatures for the month at the 2 and 20 centimeter levels for comparison with similar data during the progress of the different series. The first of the two columns under any date contains the indications of the thermometer at the higher level, the second those of the thermometer at the lower level.

TABLE XI.—*Free air temperatures at Mount Weather, Oct. 1, 2, 1912.*

Hour.	526 meters (surface).			1,000 meters.			1,500 meters.		
	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.
	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.
1 a. m.	9.3	9.1	−1.3	9.7	8.6	+1.0	10.4	7.6	+1.9
2 a. m.	8.4	8.5	−1.9	7.5	7.8	+0.2	6.7	7.1	+1.4
3 a. m.	7.7	7.7	−2.7	6.2	6.4	−1.2	4.3	5.8	+0.1
4 a. m.	7.1	7.1	−3.3	5.5	5.7	−1.9	6.3	5.6	−0.1
5 a. m.	6.6	6.5	−3.9	5.3	5.4	−2.2	6.1	6.0	+0.3
6 a. m.	5.7	6.2	−4.2	5.4	5.3	−2.3	5.6	5.7	0.0
7 a. m.	6.3	6.9	−3.5	5.3	5.3	−2.3	5.4	5.6	−0.1
8 a. m.	8.8	8.0	−2.4	5.2	5.3	−2.3	5.8	5.6	−0.1
9 a. m.	8.8	9.2	−1.2	5.5	5.5	−2.1	5.6	5.7	0.0
10 a. m.	10.0	10.5	+0.1	5.9	6.1	−1.5	5.7	5.7	0.0
11 a. m.	12.6	12.0	+1.6	6.8	6.8	−0.8	5.7	5.6	−0.1
12 noon	13.4	13.4	+3.0	7.7	7.5	−0.1	5.3	5.5	−0.2
1 p. m.	14.2	14.3	+3.9	7.9	8.6	+1.0	5.5	5.8	+0.2
2 p. m.	15.0	14.8	+4.4	10.1	9.3	+1.7	6.6	6.0	+0.3
3 p. m.	15.1	14.8	+4.4	10.0	9.4	+1.8	5.8	5.5	−0.2
4 p. m.	14.3	14.2	+3.8	8.2	8.9	+1.3	4.0	5.0	−0.7
5 p. m.	13.1	13.1	+2.7	8.5	8.9	+1.3	5.1	5.1	−0.6
6 p. m.	11.9	12.1	+1.7	10.0	9.0	+1.4	6.2	5.2	−0.5
7 p. m.	11.2	11.4	+1.0	8.4	8.7	+1.1	4.4	4.9	−0.8
8 p. m.	11.1	10.8	+0.4	7.6	8.3	+0.7	4.1	4.6	−1.1
9 p. m.	10.1	10.5	+0.1	8.9	8.4	+0.8	5.4	5.2	−0.5
10 p. m.	10.2	10.0	−0.4	8.8	8.5	+0.9	6.2	5.6	−0.1
11 p. m.	9.8	9.8	−0.6	7.8	8.4	+0.8	5.1	5.7	0.0
12 midnight	9.5	9.5	−0.9	8.7	8.7	+1.1	5.7	7.1	+1.4
Means	10.4	....	....	7.6	....	....	5.7	....	....

TABLE XII.—*Free air temperatures at Mount Weather, 10:30 a. m. Nov. 14, to 10:30 a. m. Nov. 15, 1912.*

Hour.	526 meters (surface). Corrected.	526 meters (surface). Smoothed.	526 meters (surface). Departures.	1,000 meters. Corrected.	1,000 meters. Smoothed.	1,000 meters. Departures.	1,500 meters. Corrected.	1,500 meters. Smoothed.	1,500 meters. Departures.
	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.
1 a. m.	3.1	3.1	−0.9	−1.7	−1.8	−1.0	−6.1	−5.9	−0.9
2 a. m.	3.1	3.0	−1.0	−2.6	−1.8	−1.0	−6.4	−6.0	−1.0
3 a. m.	2.9	2.9	−1.1	−1.1	−1.6	−0.8	−5.6	−5.9	−0.9
4 a. m.	2.8	2.8	−1.2	−1.2	−1.4	−0.6	−5.8	−5.9	−0.9
5 a. m.	2.7	2.8	−1.2	−1.8	−1.6	−0.8	−6.4	−5.9	−0.9
6 a. m.	2.8	2.7	−1.3	−1.8	−1.6	−0.8	−5.4	−5.3	−0.3
7 a. m.	2.7	2.8	−1.2	−1.3	−1.3	−0.5	−4.2	−4.5	+0.5
8 a. m.	2.9	2.9	−1.1	−0.9	−1.0	−0.2	−4.0	−4.0	+1.0
9 a. m.	3.1	3.2	−0.8	−0.7	−0.6	+0.2	−3.9	−3.8	+1.2
10 a. m.	3.6	3.9	−0.1	−0.1	−0.2	+0.6	−3.5	−3.7	+1.3
11 a. m.	5.1	4.9	+0.9	0.1	−0.1	+0.7	−3.6	−3.8	+1.2
12 noon.	5.9	6.0	+2.0	−0.3	−0.1	+0.7	−4.2	−4.0	+1.0
1 p. m.	7.1	6.7	+2.7	−0.2	0.0	+0.8	−4.1	−4.1	+0.9
2 p. m.	7.0	7.1	+3.1	0.5	0.4	+1.2	−4.1	−4.2	+0.8
3 p. m.	7.3	7.0	+3.0	0.9	0.8	+1.6	−4.5	−4.3	+0.7
4 p. m.	6.6	6.0	+2.0	0.9	0.9	+1.7	−4.2	−4.0	+1.0
5 p. m.	4.1	4.9	+0.9	0.8	0.6	+1.4	−3.4	−4.0	+1.0
6 p. m.	4.1	3.9	−0.1	0.0	0.0	+0.8	−4.3	−4.5	+0.5
7 p. m.	3.5	3.6	−0.4	−0.9	−0.6	+0.2	−5.8	−5.3	−0.3
8 p. m.	3.3	3.4	−0.6	−1.0	−1.0	−0.2	−5.8	−5.7	−0.7
9 p. m.	3.5	3.3	−0.7	−1.0	−1.3	−0.5	−5.5	−6.0	−1.0
10 p. m.	3.2	3.2	−0.8	−1.8	−1.5	−0.7	−6.6	−6.0	−1.0
11 p. m.	2.9	3.0	−1.0	−1.7	−1.5	−0.7	−5.9	−5.9	−0.9
12 midnight.	3.0	3.0	−1.0	−1.1	−1.5	−0.7	−5.3	−5.8	−0.8
Means.	4.0	....	....	−0.8	....	....	−5.0	....	....

Hour.	2,000 meters. Corrected.	2,000 meters. Smoothed.	2,000 meters. Departures.	2,500 meters. Corrected.	2,500 meters. Smoothed.	2,500 meters. Departures.
	°C.	°C.	°C.	°C.	°C.	°C.
1 a. m.	−7.9	−8.2	−0.1	− 9.7	− 9.7	+0.3
2 a. m.	−9.2	−8.7	−0.6	− 9.5	− 9.6	+0.4
3 a. m.	−9.0	−9.1	−1.0	− 9.5	− 9.4	+0.6
4 a. m.	−9.2	−9.4	−1.3	− 9.2	− 9.4	+0.6
5 a. m.	−9.9	−9.4	−1.3	− 9.4	− 9.4	+0.6
6 a. m.	−9.2	−9.3	−1.2	− 9.5	− 9.7	+0.3
7 a. m.	−8.3	−8.4	−0.3	−10.2	−10.1	−0.1
8 a. m.	−7.6	−7.5	+0.6	−10.6	−10.2	−0.2
9 a. m.	−6.7	−6.9	+1.2	− 9.9	−10.0	0.0
10 a. m.	−6.5	−6.7	+1.4	− 9.6	− 9.6	+0.4
11 a. m.	−6.9	−6.8	+1.3	− 9.4	− 9.5	+0.5
12 noon.	−6.9	−6.9	+1.2	− 9.4	− 9.4	+0.6
1 p. m.	−6.8	−6.9	+1.2	− 9.5	− 9.6	+0 4
2 p. m.	−7.1	−7.7	+0.4	−10.0	−10.4	−0.4
3 p. m.	−9.1	−8.5	−0.4	−11.7	−11.2	−1.2
4 p. m.	−9.4	−8.9	−0.8	−11.8	−11.7	−1.7
5 p. m.	−8.2	−8.5	−0.4	−11.7	−11.7	−1.7
6 p. m.	−8.0	−8.3	−0.2	−11.5	−11.2	−1.2
7 p. m.	−8.6	−8.2	−0.1	−10.5	−10.5	−0.5
8 p. m.	−8.1	−7.4	+0.7	− 9.5	− 9.8	+0.2
9 p. m.	−5.5	−7.6	+0.5	− 9.4	− 9.6	+0.4
10 p. m.	−9.1	−7.9	+0.2	− 9.8	− 9.7	+0.3
11 p. m.	−9.2	−8.6	−0.5	− 9.9	− 9.8	+0.2
12 midnight.	−7.6	−8.2	−0.1	− 9.8	− 9.8	+0.2
Means.	−8.1	....	....	−10.0	....	....

TABLE XIII.—*Absolute humidities at Mount Weather, 10:30 a. m. Nov. 14 to 10:30 a. m. Nov. 15, 1912.*

Hour.	526 meters (surface).			1,000 meters.			1,500 meters.		
	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.
	g./cu.m.	*g./cu.m.*	*g./cu.m.*	*g./cu.m.*	*g./cu.m.*	*g./cu.m.*	*g./cu.m.*	*g./cu.m.*	*g./cu.m.*
1 a. m.	3.5	3.7	−0.5	3.3	3.3	−0.1	2.7	2.7	0.0
2 a. m.	3.4	3.7	−0.5	3.4	3.3	−0.1	2.8	2.7	0.0
3 a. m.	4.1	3.8	−0.4	3.1	3.1	−0.3	2.7	2.7	0.0
4 a. m.	4.0	4.1	−0.1	2.8	2.9	−0.5	2.6	2.6	−0.1
5 a. m.	4.1	4.1	−0.1	2.7	2.8	−0.6	2.5	2.5	−0.2
6 a. m.	4.1	4.2	0.0	2.9	3.0	−0.4	2.4	2.5	−0.2
7 a. m.	4.3	4.3	+0.1	3.3	3.3	−0.1	2.5	2.5	−0.2
8 a. m.	4.4	4.4	+0.2	3.6	3.6	+0.2	2.7	2.7	0.0
9 a. m.	4.5	4.6	+0.4	3.8	3.7	+0.3	2.9	2.8	+0.1
10 a. m.	4.8	4.7	+0.5	3.8	3.8	+0.4	2.9	2.6	−0.1
11 a. m.	4.9	4.7	+0.5	3.8	3.7	+0.3	2.1	2.4	−0.3
12 noon.	4.5	4.7	+0.5	3.6	3.6	+0.2	2.1	2.2	−0.5
1 p. m.	4.8	4.5	+0.3	3.5	3.5	+0.1	2.5	2.4	−0.3
2 p. m.	4.3	4.3	+0.1	3.5	3.5	+0.1	2.7	2.7	0.0
3 p. m.	3.9	4.0	−0.2	3.6	3.7	+0.3	2.9	2.9	+0.2
4 p. m.	3.9	4.2	0.0	3.9	3.8	+0.4	3.0	3.0	+0.3
5 p. m.	4.9	4.4	+0.2	4.0	3.9	+0.5	3.1	3.0	+0.3
6 p. m.	4.3	4.4	+0.2	3.8	3.8	+0.4	3.0	3.0	+0.3
7 p. m.	4.1	4.1	−0.1	3.5	3.5	+0.1	2.8	2.8	+0.1
8 p. m.	3.8	3.9	−0.3	3.2	3.3	−0.1	2.6	2.6	−0.1
9 p. m.	3.8	3.8	−0.4	3.2	3.3	−0.1	2.5	2.6	−0.1
10 p. m.	3.9	4.0	−0.2	3.4	3.3	−0.1	2.7	2.6	−0.1
11 p. m.	4.2	4.1	−0.1	3.3	3.3	−0.1	2.7	2.7	0.0
12 midnight	4.1	3.9	−0.3	3.1	3.2	−0.2	2.6	2.7	0.0
Means	4.2			3.4			2.7		

Hour.	2,000 meters.			2,500 meters.		
	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.
	g./cu.m.	*g./cu.m.*	*g./cu.m.*	*g./cu.m.*	*g./cu.m.*	*g./cu.m.*
1 a. m.	2.5	2.4	+0.4	1.7	1.7	+0.3
2 a. m.	2.3	2.3	+0.3	1.6	1.6	+0.2
3 a. m.	2.1	2.1	+0.1	1.4	1.4	0.0
4 a. m.	1.9	1.9	−0.1	1.2	1.2	−0.2
5 a. m.	1.7	1.8	−0.2	1.1	1.1	−0.3
6 a. m.	1.7	1.7	−0.3	1.1	1.2	−0.2
7 a. m.	1.8	1.9	−0.1	1.3	1.3	−0.1
8 a. m.	2.1	2.0	0.0	1.5	1.5	+0.1
9 a. m.	2.2	2.1	+0.1	1.6	1.6	+0.2
10 a. m.	2.1	1.9	−0.1	1.6	1.4	0.0
11 a. m.	1.4	1.6	−0.4	1.1	1.3	−0.1
12 noon.	1.3	1.5	−0.5	1.1	1.2	−0.2
1 p. m.	1.7	1.6	−0.4	1.4	1.3	−0.1
2 p. m.	1.9	1.8	−0.2	1.4	1.3	−0.1
3 p. m.	1.9	1.9	−0.1	1.1	1.2	−0.2
4 p. m.	2.0	2.1	+0.1	1.1	1.2	−0.2
5 p. m.	2.4	2.3	+0.3	1.5	1.5	+0.1
6 p. m.	2.5	2.4	+0.4	1.8	1.6	+0.2
7 p. m.	2.4	2.4	+0.4	1.5	1.6	+0.2
8 p. m.	2.3	2.3	+0.3	1.5	1.6	+0.2
9 p. m.	2.1	2.1	+0.1	1.7	1.6	+0.2
10 p. m.	2.0	2.1	+0.1	1.5	1.6	+0.2
11 p. m.	2.2	2.2	+0.2	1.6	1.6	+0.2
12 midnight	2.5	2.4	+0.4	1.8	1.7	+0.3
Means	2.0			1.4		

TABLE XIV.—*Free air temperatures at Mount Weather, 5:30 p. m., Nov. 14 to 5:30 p. m., Nov. 15, 1912.*

Hour.	526 meters (surface).			1,000 meters.			1,500 meters.		
	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.
	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.
1 a. m.	1.7	1.7	−0.6	−3.3	−3.3	−1.1	−7.5	−7.3	−1.1
2 a. m.	1.7	1.6	−0.7	−4.1	−3.3	−1.1	−7.8	−7.4	−1.2
3 a. m.	1.5	1.5	−0.8	−2.6	−3.1	−0.9	−7.0	−7.4	−1.2
4 a. m.	1.4	1.4	−0.9	−2.7	−2.9	−0.7	−7.3	−7.4	−1.2
5 a. m.	1.3	1.4	−0.9	−3.3	−3.1	−0.9	−7.9	−7.4	−1.2
6 a. m.	1.4	1.3	−1.0	−3.3	−3.2	−1.0	−6.9	−6.9	−0.7
7 a. m.	1.3	1.4	−0.9	−2.9	−2.9	−0.7	−5.8	−6.1	+0.1
8 a. m.	1.5	1.5	−0.8	−2.4	−2.5	−0.3	−5.7	−5.7	+0.5
9 a. m.	1.7	1.8	−0.5	−2.2	−2.1	+0.1	−5.6	−5.5	+0.7
10 a. m.	2.2	2.3	0.0	−1.6	−1.6	+0.6	−5.2	−5.1	+1.1
11 a. m.	3.0	2.8	+0.5	−1.0	−1.1	+1.1	−4.4	−4.8	+1.4
12 noon	3.3	3.4	+1.1	−0.8	−0.9	+1.3	−4.9	−4.8	+1.4
1 p. m.	4.0	3.9	+1.6	−0.9	−0.8	+1.4	−5.0	−4.8	+1.4
2 p. m.	4.5	4.3	+2.0	−0.7	−0.8	+1.4	−4.6	−4.6	+1.6
3 p. m.	4.5	4.3	+2.0	−0.7	−0.7	+1.5	−4.3	−4.6	+1.6
4 p. m.	3.8	3.8	+1.5	−0.7	−0.7	+1.5	−4.9	−4.9	+1.3
5 p. m.	3.2	3.2	+0.9	−0.8	−1.0	+1.2	−5.6	−5.3	+0.9
6 p. m.	2.7	2.7	+0.4	−1.5	−1.6	+0.6	−5.3	−5.9	+0.3
7 p. m.	2.1	2.3	0.0	−2.4	−2.1	+0.1	−6.8	−6.4	−0.2
8 p. m.	1.9	2.0	−0.3	−2.5	−2.5	−0.3	−7.0	−6.8	−0.6
9 p. m.	2.1	1.9	−0.4	−2.5	−2.8	−0.6	−6.7	−7.2	−1.0
10 p. m.	1.8	1.8	−0.5	−3.3	−3.0	−0.8	−7.8	−7.2	−1.0
11 p. m.	1.5	1.6	−0.7	−3.2	−3.0	−0.8	−7.1	−7.2	−1.0
12 midnight	1.6	1.6	−0.7	−2.6	−3.0	−0.8	−6.6	−7.1	−0.9
Means	2.3	....	....	−2.2	....	....	−6.2	....	....

Hour.	2,000 meters.			2,500 meters.		
	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.
	°C.	°C.	°C.	°C.	°C.	°C.
1 a. m.	− 9.0	− 9.3	0.0	−10.0	−10.0	+0.7
2 a. m.	−10.4	− 9.9	−0.6	−10.2	−10.2	+0.5
3 a. m.	−10.3	−10.5	−1.2	−10.4	−10.4	+0.3
4 a. m.	−10.7	−10.8	−1.5	−10.6	−10.7	0.0
5 a. m.	−11.4	−11.0	−1.7	−11.0	−11.0	−0.3
6 a. m.	−10.8	−10.7	−1.4	−11.4	−11.6	−0.9
7 a. m.	−10.0	−10.1	−0.8	−12.4	−12.3	−1.6
8 a. m.	− 9.5	− 9.4	−0.1	−13.2	−12.8	−2.1
9 a. m.	− 8.7	− 8.9	+0.4	−12.7	−12.9	−2.2
10 a. m.	− 8.5	− 8.6	+0.7	−12.8	−12.8	−2.1
11 a. m.	− 8.5	− 8.6	+0.7	−12.8	−12.9	−2.2
12 noon	− 8.9	− 8.9	+0.4	−13.0	−13.0	−2.3
1 p. m.	− 9.2	− 9.0	+0.3	−13.3	−12.7	−2.0
2 p. m.	− 8.9	− 8.9	+0.4	−11.7	−11.7	−1.0
3 p. m.	− 8.7	− 8.8	+0.5	−10.2	−10.2	+0.5
4 p. m.	− 8.9	− 9.0	+0.3	− 8.8	− 9.1	+1.6
5 p. m.	− 9.3	− 8.8	+0.5	− 8.3	− 8.9	+1.8
6 p. m.	− 8.3	− 8.9	+0.4	− 9.5	− 8.9	+1.8
7 p. m.	− 9.0	− 8.6	+0.7	− 8.8	− 8.8	+1.9
8 p. m.	− 8.6	− 7.9	+1.4	− 8.1	− 8.4	+2.3
9 p. m.	− 6.2	− 8.2	+1.1	− 8.4	− 8.5	+2.2
10 p. m.	− 9.9	− 8.7	+0.6	− 9.0	− 9.0	+1.7
11 p. m.	−10.0	− 9.5	−0.2	− 9.5	− 9.4	+1.3
12 midnight	− 8.6	− 9.2	+0.1	− 9.8	− 9.8	+0.9
Means	− 9.3	....	....	−10.7	....	....

TABLE XV.—*Absolute humidities at Mount Weather, 5:30 p. m. Nov. 14 to 5:30 p. m. Nov. 15, 1912.*

Hour.	526 meters (surface).			1,000 meters.			1,500 meters.		
	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.
	g./cu. m.	g./cu. m.	g./cu. m.	g./cu. m.	g./cu. m.	g./cu. m.	g./cu. m.	g./cu. m.	g./cu. m.
1 a. m.	3.4	3.5	−0.4	3.3	3.3	−0.1	2.7	2.7	+0.1
2 a. m.	3.2	3.5	−0.4	3.4	3.3	−0.1	2.8	2.7	+0.1
3 a. m.	3.8	3.6	−0.3	3.1	3.1	−0.3	2.7	2.7	+0.1
4 a. m.	3.7	3.8	−0.1	2.8	2.9	−0.5	2.6	2.6	0.0
5 a. m.	3.8	3.8	−0.1	2.7	2.8	−0.6	2.5	2.5	−0.1
6 a. m.	3.8	3.8	−0.1	2.9	3.0	−0.4	2.4	2.5	−0.1
7 a. m.	3.9	3.9	0.0	3.3	3.3	−0.1	2.5	2.5	−0.1
8 a. m.	4.0	4.0	+0.1	3.6	3.6	+0.2	2.7	2.7	+0.1
9 a. m.	4.1	4.1	+0.2	3.8	3.7	+0.3	2.9	2.8	+0.2
10 a. m.	4.3	4.2	+0.3	3.8	3.7	+0.3	2.9	2.9	+0.3
11 a. m.	4.1	4.2	+0.3	3.6	3.7	+0.3	2.9	2.8	+0.2
12 noon	4.2	4.2	+0.3	3.7	3.7	+0.3	2.7	2.7	+0.1
1 p. m.	4.2	4.0	+0.1	3.8	3.8	+0.4	2.6	2.6	0.0
2 p. m.	3.7	4.0	+0.1	3.8	3.7	+0.3	2.4	2.4	−0.2
3 p. m.	4.2	4.0	+0.1	3.6	3.6	+0.2	2.1	2.2	−0.4
4 p. m.	4.0	4.0	+0.1	3.5	3.5	+0.1	2.1	2.1	−0.5
5 p. m.	3.9	4.1	+0.2	3.4	3.6	+0.2	2.2	2.4	−0.2
6 p. m.	4.5	4.2	+0.3	3.8	3.6	+0.2	3.0	2.7	+0.1
7 p. m.	4.2	4.2	+0.3	3.5	3.5	+0.1	2.8	2.8	+0.2
8 p. m.	3.9	4.0	+0.1	3.2	3.3	−0.1	2.6	2.6	0.0
9 p. m.	3.8	3.9	0.0	3.2	3.3	−0.1	2.5	2.6	0.0
10 p. m.	3.9	3.9	0.0	3.4	3.3	−0.1	2.7	2.6	0.0
11 p. m.	4.1	4.0	+0.1	3.3	3.3	−0.1	2.7	2.7	+0.1
12 midnight	4.0	3.8	−0.1	3.1	3.2	−0.2	2.6	2.7	+0.1
Means	3.9			3.4			2.6		

Hour.	2,000 meters.			2,500 meters.		
	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.
	g./cu. m.	g./cu. m.	g./cu. m.	g./cu. m.	g./cu. m.	g./cu. m.
1 a. m.	2.5	2.4	+0.4	1.7	1.7	+0.3
2 a. m.	2.3	2.3	+0.3	1.6	1.6	+0.2
3 a. m.	2.1	2.1	+0.1	1.4	1.4	0.0
4 a. m.	1.9	1.9	−0.1	1.2	1.2	−0.2
5 a. m.	1.7	1.8	−0.2	1.1	1.1	−0.3
6 a. m.	1.7	1.7	−0.3	1.1	1.2	−0.2
7 a. m.	1.8	1.9	−0.1	1.3	1.3	−0.1
8 a. m.	2.1	2.0	0.0	1.5	1.5	+0.1
9 a. m.	2.2	2.1	+0.1	1.6	1.6	+0.2
10 a. m.	2.1	2.1	+0.1	1.6	1.6	+0.2
11 a. m.	1.9	2.0	0.0	1.6	1.6	+0.2
12 noon	2.0	2.0	0.0	1.5	1.5	+0.1
1 p. m.	2.0	2.0	0.0	1.5	1.5	+0.1
2 p. m.	2.0	1.9	−0.1	1.4	1.4	0.0
3 p. m.	1.8	1.7	−0.3	1.4	1.3	−0.1
4 p. m.	1.4	1.4	−0.6	1.2	1.1	−0.3
5 p. m.	1.1	1.7	−0.3	0.7	1.2	−0.2
6 p. m.	2.5	2.0	0.0	1.8	1.3	−0.1
7 p. m.	2.4	2.4	+0.4	1.5	1.6	+0.2
8 p. m.	2.3	2.3	+0.3	1.5	1.6	+0.2
9 p. m.	2.1	2.1	+0.1	1.7	1.6	+0.2
10 p. m.	2.0	2.1	+0.1	1.5	1.6	+0.2
11 p. m.	2.2	2.2	+0.2	1.6	1.6	+0.2
12 midnight	2.5	2.4	+0.4	1.8	1.7	+0.3
Means	2.0			1.4		

TABLE XVI.—*Free air temperatures at Mount Weather, Dec. 6, 7, 1912.*

Hour.	526 meters (surface).			1,000 meters.			1,500 meters.		
	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.
	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.
1 a. m.	8.0	8.1	−1.2	8.3	8.3	+0.5	8.7	8.2	+2.2
2 a. m.	7.5	7.5	−1.8	9.5	8.9	+1.1	9.8	9.3	+3.3
3 a. m.	7.0	7.0	−2.3	8.8	8.2	+0.4	9.3	9.1	+3.1
4 a. m.	6.4	6.4	−2.9	6.4	7.6	−0.2	8.1	9.1	+3.1
5 a. m.	5.9	6.0	−3.3	7.7	7.4	−0.4	9.9	9.1	+3.1
6 a. m.	5.6	5.9	−3.4	8.2	7.8	0.0	9.4	8.7	+2.7
7 a. m.	6.1	6.1	−3.2	7.5	7.5	−0.3	6.7	7.0	+1.0
8 a. m.	6.7	6.6	−2.7	6.7	6.9	−0.9	5.0	4.7	−1.3
9 a. m.	7.1	7.2	−2.1	6.4	6.3	−1.5	2.5	2.7	−3.3
10 a. m.	7.9	8.0	−1.3	5.9	5.8	−2.0	0.7	2.7	−3.3
11 a. m.	9.0	9.4	+0.1	5.2	6.0	−1.8	5.0	3.3	−2.7
12 noon.	11.5	10.8	+1.5	6.9	6.6	−1.2	4.1	4.5	−1.5
1 p. m.	11.8	12.1	+2.8	7.7	7.8	0.0	4.4	4.8	−1.2
2 p. m.	13.1	12.6	+3.3	8.5	8.5	+0.7	5.8	5.5	−0.5
3 p. m.	12.9	13.2	+3.9	9.2	9.1	+1.3	6.3	6.1	+0.1
4 p. m.	13.6	13.0	+3.7	9.5	9.3	+1.5	6.1	6.0	0.0
5 p. m.	12.6	12.5	+3.2	9.1	9.2	+1.4	5.5	5.8	−0.2
6 p. m.	11.3	11.8	+2.5	9.1	9.0	+1.2	5.7	5.6	−0.4
7 p. m.	11.4	11.2	+1.9	8.7	8.6	+0.8	5.7	5.6	−0.4
8 p. m.	10.9	10.8	+1.5	8.1	8.2	+0.4	5.4	5.1	−0.9
9 p. m.	10.2	10.5	+1.2	7.7	7.8	0.0	4.1	4.6	−1.4
10 p. m.	10.5	10.0	+0.7	7.6	7.5	−0.3	4.4	4.3	−1.7
11 p. m.	9.2	9.5	+0.2	7.3	7.3	−0.5	4.3	5.0	−1.0
12 midnight.	8.9	8.7	−0.6	7.1	7.6	−0.2	6.2	6.4	+0.4
Means.	9.3	....	....	7.8	....	....	6.0	....	....

Hour.	2,000 meters.			2,500 meters.			3,000 meters.		
	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.
	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.
1 a. m.	6.9	6.8	+2.0	3.2	3.2	+0.6	−0.6	−0.4	−1.0
2 a. m.	7.2	7.0	+2.2	3.5	3.7	+1.1	−0.9	−0.4	−1.0
3 a. m.	6.8	6.9	+2.1	4.3	4.5	+1.9	1.4	1.2	+0.6
4 a. m.	6.8	7.2	+2.4	5.7	5.5	+2.9	3.2	2.8	+2.2
5 a. m.	7.9	7.3	+2.5	6.6	6.1	+3.5	3.7	3.4	+2.8
6 a. m.	7.3	7.0	+2.2	5.9	5.5	+2.9	3.2	3.1	+2.5
7 a. m.	5.9	6.0	+1.2	4.0	4.3	+1.7	2.3	2.4	+1.8
8 a. m.	4.8	5.0	+0.2	2.9	3.2	+0.6	1.6	1.6	+1.0
9 a. m.	4.2	4.2	−0.6	2.7	2.6	0.0	1.0	1.1	+0.5
10 a. m.	3.5	3.7	−1.1	2.1	2.0	−0.6	0.8	0.8	+0.2
11 a. m.	3.3	2.8	−2.0	1.3	1.7	−0.9	0.6	0.8	+0.2
12 noon.	1.5	2.1	−2.7	1.8	1.1	−1.5	0.9	0.3	−0.3
1 p. m.	1.4	2.3	−2.5	0.1	0.2	−2.4	−0.6	0.2	−0.4
2 p. m.	4.1	3.2	−1.6	−1.3	−0.2	−2.8	0.3	−0.6	−1.2
3 p. m.	4.2	3.7	−1.1	0.6	0.3	−2.3	−1.6	−1.2	−1.8
4 p. m.	2.8	3.5	−1.3	1.6	1.3	−1.3	−2.2	−1.9	−2.5
5 p. m.	3.5	3.6	−1.2	1.6	1.7	−0.9	−2.0	−1.9	−2.5
6 p. m.	4.4	4.9	+0.1	1.9	2.0	−0.6	−1.6	−1.4	−2.0
7 p. m.	6.9	5.2	+0.4	2.6	2.3	−0.3	−0.7	−0.6	−1.2
8 p. m.	4.2	4.5	−0.3	2.5	2.3	−0.3	0.5	0.3	−0.3
9 p. m.	2.3	3.8	−1.0	1.7	2.0	−0.6	1.2	0.9	+0.3
10 p. m.	4.8	4.2	−0.6	1.7	1.9	−0.7	1.0	1.3	+0.7
11 p. m.	5.6	5.5	+0.7	2.4	2.3	−0.3	1.8	1.0	+0.4
12 midnight.	6.2	6.2	+1.4	2.9	2.8	+0.2	0.3	0.5	−0.1
Means.	4.8	....	....	2.6	....	....	0.6	....	....

TABLE XVII.—*Absolute humidities at Mount Weather, Dec. 6, 7, 1912.*

Hour.	526 meters (surface).			1,000 meters.			1,500 meters.		
	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.
	g./cu.m.	*g./cu. m.*	*g./cu.m.*	*g./cu.m.*	*g./cu. m.*	*g./cu.m.*	*g./cu.m.*	*g./cu. m.*	*g./cu.m.*
1 a. m.	4.8	4.8	−0.8	4.1	3.5	−0.9	2.9	3.0	−0.6
2 a. m.	5.3	5.2	−0.4	3.5	3.8	−0.6	3.0	3.0	−0.6
3 a. m.	5.5	5.4	−0.2	3.8	3.9	−0.5	3.0	3.0	−0.6
4 a. m.	5.4	5.4	−0.2	4.4	4.0	−0.4	2.9	2.9	−0.7
5 a. m.	5.4	5.5	−0.1	3.9	4.1	−0.3	2.8	3.1	−0.5
6 a. m.	5.8	5.8	+0.2	3.9	4.2	−0.2	3.6	3.9	+0.3
7 a. m.	6.1	6.1	+0.5	4.9	4.6	+0.2	5.3	4.5	+0.9
8 a. m.	6.4	6.4	+0.8	5.1	5.0	+0.6	4.6	4.6	+1.0
9 a. m.	6.6	6.6	+1.0	5.1	5.4	+1.0	4.0	4.6	+1.0
10 a. m.	6.8	6.9	+1.3	6.1	5.8	+1.4	5.3	5.1	+1.5
11 a. m.	7.2	7.0	+1.4	6.2	6.2	+1.8	6.1	5.7	+2.1
12 noon	7.1	6.9	+1.3	6.2	6.3	+1.9	5.7	5.8	+2.2
1 p. m.	6.3	7.0	+1.4	6.5	6.2	+1.8	5.6	5.4	+1.8
2 p. m.	7.7	6.9	+1.3	6.0	5.9	+1.5	4.8	4.8	+1.2
3 p. m.	6.8	6.8	+1.2	5.2	5.2	+0.8	3.9	3.9	+0.3
4 p. m.	5.8	5.9	+0.3	4.3	4.4	0.0	3.1	3.1	−0.5
5 p. m.	5.0	5.1	−0.5	3.7	3.8	−0.6	2.4	2.6	−1.0
6 p. m.	4.4	4.6	−1.0	3.4	3.5	−0.9	2.4	2.5	−1.1
7 p. m.	4.5	4.6	−1.0	3.4	3.2	−1.2	2.7	2.1	−1.5
8 p. m.	4.8	4.6	−1.0	2.9	3.1	−1.3	1.3	1.9	−1.7
9 p. m.	4.5	4.4	−1.2	2.9	3.2	−1.2	1.8	2.0	−1.6
10 p. m.	3.9	4.1	−1.5	3.9	3.3	−1.1	2.9	2.6	−1.0
11 p. m.	3.9	4.0	−1.6	3.2	3.4	−1.0	3.1	3.0	−0.6
12 midnight	4.3	4.3	−1.3	3.0	3.4	−1.0	3.1	3.0	−0.6
Means	5.6	....	....	4.4	....	....	3.6	....	....

Hour.	2,000 meters.			2,500 meters.			3,000 meters.		
	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.	Corrected.	Smoothed.	Departures.
	g./cu.m.	*g./cu. m.*	*g./cu.m.*	*g./cu.m.*	*g./cu. m.*	*g./cu.m.*	*g./cu.m.*	*g./cu. m.*	*g./cu.m.*
1 a. m.	2.4	2.3	−0.5	1.8	1.7	−0.5	1.2	1.0	−0.4
2 a. m.	2.8	2.7	−0.1	2.1	2.1	−0.1	1.2	1.2	−0.2
3 a. m.	2.8	2.9	+0.1	2.3	2.2	0.0	1.1	1.2	−0.2
4 a. m.	3.0	3.1	+0.3	2.3	2.3	+0.1	1.3	1.3	−0.1
5 a. m.	3.5	3.5	+0.7	2.4	2.4	+0.2	1.6	1.5	+0.1
6 a. m.	3.9	3.8	+1.0	2.4	2.5	+0.3	1.7	1.7	+0.3
7 a. m.	4.1	4.0	+1.2	2.6	2.6	+0.4	1.8	1.8	+0.4
8 a. m.	4.1	4.1	+1.3	2.9	3.0	+0.8	1.9	1.9	+0.5
9 a. m.	4.1	4.3	+1.5	3.5	3.4	+1.2	1.9	1.9	+0.5
10 a. m.	4.8	4.4	+1.6	3.9	3.6	+1.4	1.9	1.9	+0.5
11 a. m.	4.4	4.6	+1.8	3.5	3.5	+1.3	1.8	1.7	+0.3
12 noon	4.5	4.4	+1.6	3.0	3.1	+0.9	1.3	1.5	+0.1
1 p. m.	4.3	3.8	+1.0	2.9	3.0	+0.8	1.4	1.4	0.0
2 p. m.	2.5	3.1	+0.3	3.2	3.1	+0.9	1.6	1.5	+0.1
3 p. m.	2.5	2.6	−0.2	3.1	2.8	+0.6	1.6	1.6	+0.2
4 p. m.	2.7	2.1	−0.7	2.1	1.9	−0.3	1.5	1.4	0.0
5 p. m.	1.0	1.6	−1.2	0.6	1.2	−1.0	1.2	1.3	−0.1
6 p. m.	1.2	1.4	−1.4	0.8	1.0	−1.2	1.2	1.2	−0.2
7 p. m.	2.0	1.1	−1.7	1.7	0.9	−1.3	1.2	1.1	−0.3
8 p. m.	0.2	1.1	−1.7	0.4	1.2	−1.0	0.8	1.0	−0.4
9 p. m.	1.0	1.1	−1.7	1.4	1.2	−1.0	1.1	1.1	−0.3
10 p. m.	2.2	1.5	−1.3	1.8	1.4	−0.8	1.5	1.1	−0.3
11 p. m.	1.4	1.7	−1.1	1.0	1.4	−0.8	0.8	1.0	−0.4
12 midnight	1.6	1.8	−1.0	1.3	1.4	−0.8	0.7	0.9	−0.5
Means	2.8	....	....	2.2	....	....	1.4	....	....

TABLE XVIII.—*Soil temperatures at 2 and at 20 centimeters below surface.*

Hours.	October means.		Oct. 1.		Oct. 2.		Oct. 7.		Oct. 8.		Oct. 15.	
	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.
1 a. m.	13.3	17.7	11.8	17.2	11.7	16.6	15.6	19.8	14.3	19.6	11.9	17.2
2 a. m.	13.0	17.6	11.6	17.1	11.6	16.5	15.4	19.7	13.8	19.3	11.7	17.2
3 a. m.	12.7	17.4	11.2	16.9	11.2	16.3	15.1	19.4	13.3	19.1	11.6	17.0
4 a. m.	12.5	17.4	11.1	16.7	11.1	16.2	15.0	19.4	12.8	18.9	11.3	16.8
5 a. m.	12.3	17.2	10.8	16.7	10.7	16.1	14.8	19.3	12.3	18.7	11.2	16.7
6 a. m.	12.2	17.3	10.6	16.6	10.5	15.9	14.7	19.1	12.0	18.4	11.1	16.7
7 a. m.	12.3	17.2	10.8	16.5	10.7	15.9	14.9	19.0	11.9	18.3	11.0	16.6
8 a. m.	12.7	17.2	11.9	16.4	11.9	15.9	16.0	18.9	12.5	18.3	11.6	16.6
9 a. m.	13.9	17.3	13.9	16.5	14.2	16.1	18.3	18.8	14.7	18.3	13.3	16.6
10 a. m.	15.3	17.3	15.3	16.6	16.1	16.2	18.9	18.9	15.6	18.3	14.7	16.7
11 a. m.	17.3	17.4	17.7	16.7	19.4	16.4	20.8	19.0	18.9	18.4	16.7	16.7
12 noon	18.6	17.5	18.6	16.8	21.4	16.7	22.1	19.2	21.0	18.5	17.5	16.8
1 p. m.	19.3	17.6	19.0	16.9	22.2	16.9	22.9	19.3	21.6	18.5	18.3	16.9
2 p. m.	19.3	17.7	18.9	17.1	21.9	17.1	23.1	19.3	20.7	18.7	18.2	16.9
3 p. m.	18.8	17.8	18.3	17.2	21.1	17.3	22.5	19.4	20.7	18.8	17.1	17.0
4 p. m.	17.9	17.9	17.5	17.2	19.7	17.4	21.9	19.8	19.9	18.9	16.3	17.1
5 p. m.	16.8	17.9	15.8	17.2	18.3	17.6	20.9	19.9	18.3	18.9	15.2	17.1
6 p. m.	15.9	18.0	14.7	17.2	16.9	17.7	20.0	20.0	16.7	18.9	14.3	17.2
7 p. m.	15.2	18.1	13.9	17.3	15.6	17.7	19.2	20.1	15.6	18.9	13.5	17.2
8 p. m.	14.7	18.1	13.4	17.2	15.5	17.8	18.3	20.0	15.1	18.9	12.8	16.9
9 p. m.	14.2	18.0	12.8	17.1	15.1	17.7	17.5	20.0	14.6	18.7	12.2	16.9
10 p. m.	14.1	17.9	12.6	17.1	14.8	17.7	16.7	19.9	14.2	18.6	11.7	16.7
11 p. m.	13.8	17.8	12.3	16.9	14.4	17.6	16.1	19.8	13.8	18.4	11.1	16.6
12 midnight	13.6	17.8	12.1	16.8	14.2	17.4	15.4	19.7	13.6	18.3	10.8	16.4

Hour.	Oct. 16.		Oct. 30.		Oct. 31.		November means.		Nov. 14.		Nov. 15.	
	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.
1 a. m.	10.2	16.2	11.8	......	11.1	......	6.6	......	12.3	......	5.4	......
2 a. m.	9.5	15.9	11.7	......	10.7	......	6.4	......	12.0	......	5.2	......
3 a. m.	8.9	15.7	11.6	......	10.2	......	6.2	......	11.5	......	5.1	......
4 a. m.	8.7	15.6	11.6	......	10.0	......	6.0	......	11.2	......	4.9	......
5 a. m.	8.3	15.5	11.6	......	9.7	......	5.8	......	10.3	......	4.6	......
6 a. m.	7.9	15.2	11.7	......	9.4	......	5.6	......	9.9	......	4.4	......
7 a. m.	7.7	15.0	11.7	......	8.9	......	5.5	......	9.2	......	4.3	......
8 a. m.	8.3	15.1	12.5	......	9.3	......	5.4	......	8.9	......	4.1	......
9 a. m.	10.3	15.2	13.6	......	10.6	......	6.2	......	8.9	......	4.2	......
10 a. m.	11.4	15.4	15.3	......	11.7	......	7.4	......	9.2	......	4.2	......
11 a. m.	14.8	15.6	17.2	......	13.3	......	9.0	......	11.0	......	4.3	......
12 noon	16.9	15.7	16.8	......	14.4	......	10.4	......	12.2	......	5.0	......
1 p. m.	18.5	15.9	17.6	......	15.6	......	10.9	......	12.8	......	5.1	......
2 p. m.	18.8	16.0	17.5	......	15.2	......	11.2	......	12.6	......	5.3	......
3 p. m.	18.3	16.1	16.9	......	14.4	......	11.0	......	12.1	......	5.8	......
4 p. m.	17.1	16.1	16.1	......	13.9	......	10.3	......	10.7	......	6.2	......
5 p. m.	15.6	16.1	15.0	......	12.8	......	9.3	......	9.9	......	4.7	......
6 p. m.	13.8	16.0	14.3	......	12.1	......	8.7	......	8.9	......	3.9	......
7 p. m.	12.8	16.1	13.6	......	11.7	......	7.9	......	7.9	......	3.2	......
8 p. m.	12.2	16.1	13.1	......	11.2	......	7.6	......	7.6	......	3.2	......
9 p. m.	11.7	16.1	12.8	......	11.0	......	7.2	......	6.8	......	2.6	......
10 p. m.	11.3	16.0	12.2	......	10.7	......	6.9	......	6.3	......	2.3	......
11 p. m.	11.0	15.8	11.7	......	10.3	......	6.7	......	5.9	......	2.1	......
12 midnight	10.8	15.7	11.3	......	10.2	......	6.5	......	5.7	......	1.9	......

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Height	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
Oct. 1, 1912:													
First flight—	*mm.*	*°C.*	*%*		*m. p. s.*	*m.*	*mm.*	*°C.*	*%*	*g.cu.m.*		*m. p. s.*	*Volts.*
10.14 a. m.	718.6	11.1	59	wnw.	10.3	526	718.6	11.1	59	5.9	wnw.	10.3	......
10.24 a. m.	718.6	11.4	58	w.	10.7	835	692.5	8.5	58	4.9	wnw.	16.0	0
10.35 a. m.	718.5	11.5	61	w.	9.8	1,311	653.3	3.5	67	4.1	wnw.	17.1	0
10.38 a. m.	718.5	11.3	61	w.	8.9	1,475	640.4	2.7	66	3.8	wnw.	18.1	0
10.40 a. m.	718.5	11.2	62	w.	10.3	1,654	626.4	3.7	40	2.5	wnw.	....	0
10.53 a. m.	718.4	11.1	63	w.	8.9	2,100	592.6	0.7	18	0.9	wnw.	25.7	0
10.56 a. m.	718.4	11.4	60	w.	9.8	2,285	579.1	0.7	16	0.8	wnw.	....	0
10.58 a. m.	718.4	11.6	58	w.	8.0	2,423	569.3	−0.6	15	0.7	wnw.	24.6	0
11.01 a. m.	718.4	12.0	56	w.	7.2	2,543	560.8	−0.6	14	0.6	wnw.	....	0
11.05 a. m.	718.4	12.2	54	w.	8.0	2,838	540.4	−1.6	18	0.8	wnw.	....	0
11.07 a. m.	718.4	12.2	54	w.	8.0	2,925	534.6	−0.8	16	0.7	wnw.	....	0
11.13 a. m.	718.3	12.3	48	w.	8.0	3,355	506.6	−1.0	13	0.6	wnw.	23.0	0
11.23 a. m.	718.3	12.8	45	w.	9.4	3,788	479.3	−2.5	9	0.4	wnw.	....	0
11.30 a. m.	718.2	12.8	45	w.	9.4	3,638	488.3	−2.5	8	0.3	wnw.	21.3	0
11.40 a. m.	718.2	13.1	44	w.	10.7	3,346	506.6	−0.9	8	0.4	wnw.	25.4	0
11.42 a. m.	718.2	13.1	44	w.	8.5	3,201	515.8	−1.3	7	0.3	wnw.	27.5	0
11.48 a. m.	718.2	13.2	44	w.	9.4	2,985	529.9	−0.4	6	0.3	wnw.	26.5	0
11.59 a. m.	718.1	13.3	43	w.	12.5	2,776	544.0	−2.0	7	0.3	wnw.	29.4	0
12.13 p. m.	718.0	13.4	41	w.	8.9	2,278	579.1	−2.6	25	1.0	wnw.	....	0
12.15 p. m.	718.0	13.4	40	w.	9.4	2,376	571.7	−0.9	35	1.6	wnw.	....	0
12.22 p. m.	718.0	13.5	41	w.	9.8	1,992	600.0	−1.5	46	2.0	w.	....	0
12.33 p. m.	717.9	13.6	42	w.	9.8	1,501	637.8	2.5	64	3.7	w.	....	0
12.45 p. m.	717.9	13.5	38	w.	10.7	922	684.6	6.9	50	3.8	wnw.	....	0
12.53 p. m.	717.8	13.9	42	w.	9.4	526	717.8	13.9	42	5.0	w.	9.4	......
Second flight—													
1.25 p. m.	717.7	14.1	40	w.	9.4	526	717.7	14.1	40	4.8	w.	9.4	......
1.38 p. m.	717.6	14.2	37	w.	10.7	880	688.1	9.7	42	3.8	wnw.	13.8	0
1.50 p. m.	717.6	14.2	39	w.	8.9	1,172	664.4	7.5	46	3.7	wnw.	10.7	0
2.17 p. m.	717.5	14.6	40	w.	9.8	1,724	620.8	2.4	62	3.5	wnw.	16.3	0
2.43 p. m.	717.6	14.6	39	wnw.	9.4	2,244	582.1	−2.8	75	2.9	wnw.	16.8	0
2.55 p. m.	717.6	14.6	38	wnw.	8.9	2,525	561.5	−3.9	63	2.2	nw.	30.4	0
2.56 p. m.	717.6	14.6	38	wnw.	8.9	2,695	549.5	−2.6	50	2.0	nw.	30.4	0
2.58 p. m.	717.6	14.6	38	wnw.	9.8	2,924	534.0	−2.8	40	1.6	nw.	28.3	0
2.59 p. m.	717.6	14.6	38	wnw.	9.8	3,011	528.1	−1.2	34	1.5	nw.	28.3	0
3.02 p. m.	717.6	14.6	39	w.	10.3	3,103	522.2	−1.8	28	1.2	nw.	27.3	0
3.08 p. m.	717.6	14.6	40	w.	8.0	3,192	516.4	−1.1	22	1.0	nw.	24.5	0
3.30 p. m.	717.7	14.6	40	w.	10.3	3,549	493.4	−3.2	18	0.7	nw.	27.9	......
3.46 p. m.	717.8	14.0	43	wnw.	8.5	2,951	531.6	−0.7	12	0.5	nw.	22.0	0
3.49 p. m.	717.8	14.0	43	wnw.	7.6	2,738	545.9	−2.5	11	0.4	nw.	25.0	0
3.51 p. m.	717.8	14.0	44	nw.	7.6	2,703	548.3	−1.6	11	0.5	nw.	29.1	0
3.52 p. m.	717.8	14.0	44	nw.	7.6	2,567	557.8	−5.3	12	0.4	nw.	29.1	0
4.01 p. m.	717.8	13.7	46	wnw.	7.6	2,295	577.3	−4.2	78	2.7	nw.	18.6	0
4.17 p. m.	717.9	13.6	45	wnw.	6.7	1,850	610.7	−0.6	72	3.3	nw.	17.2	0
4.23 p. m.	717.9	13.6	45	wnw.	7.6	1,378	647.6	3.0	61	3.6	nw.	13.3	0
4.38 p. m.	717.9	13.2	48	wnw.	5.8	929	684.1	7.5	52	4.1	nw.	12.8	0
4.44 p. m.	717.9	12.8	53	wnw.	6.7	526	717.9	12.8	53	5.9	wnw.	6.7	......

October 1, 1912.—First flight: Four kites were used; lifting surface, 27.2 sq. m. Wire out, 5,000 m., at maximum altitude.

There were a few Cu. from the west-northwest.

High pressure (769 mm.) was central over the lower Ohio Valley and low pressure (757 mm.) over the middle St. Lawrence Valley.

Second flight: Six kites were used; lifting surface, 38.3 sq. m. Wire out, 5,400 m.; at maximum altitude, 4,900 m.

There were a few Cu. from the west-northwest until 2.50 p. m.; from the northwest thereafter. The head kite was in Cu. at 2.55 p. m., altitude 2,500 m.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Height	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
Oct. 1, 1912:													
Third flight—	*mm.*	*°C.*	*%*		*m. p. s.*	*m.*	*mm.*	*°C.*	*%*	*g.cu.m.*		*m. p. s.*	*Volts.*
5.17 p. m..	718.1	12.4	50	wnw.	6.3	526	718.1	12.4	50	5.4	wnw.	6.3	......
5.27 p. m..	718.1	12.4	50	wnw.	7.2	930	684.3	10.0	51	4.8	nw.	14.3	0
5.39 p. m..	718.2	12.0	54	wnw.	7.2	1,451	642.5	5.6	63	4.4	nw.	16.3	0
5.53 p. m..	718.3	11.6	55	wnw.	7.6	2,078	594.4	−1.1	84	3.7	nw.	18.9	0
6.05 p. m..	718.3	11.4	57	wnw.	7.2	2,282	579.5	−2.9	81	3.1	nnw.	20.6	0
6.07 p. m..	718.3	11.4	57	wnw.	8.0	2,586	557.7	1.3	49	2.6	nnw.	22.4	0
6.20 p. m..	718.4	11.4	55	wnw.	7.6	3,231	514.9	−1.4	31	1.3	nnw.	24.4	0
6.21 p. m..	718.4	11.4	55	wnw.	7.6	3,339	507.9	−0.9	29	1.3	nnw.	24.4	0
6.33 p. m..	718.5	11.0	58	wnw.	7.6	3,597	491.7	−2.2	22	0.9	nnw.	24.5	570
6.48 p. m..	718.5	11.2	56	wnw.	8.0	3,142	520.7	−0.2	19	0.9	nnw.	22.5	420
6.50 p. m..	718.6	11.2	56	wnw.	8.0	3,053	526.6	−0.4	19	0.9	nnw.	23.5	390
7.11 p. m..	718.6	10.8	58	wnw.	9.4	2,281	579.5	2.4	15	0.9	nw.	23.2	110
7.15 p. m..	718.6	10.8	58	wnw.	9.8	2,025	598.1	−0.2	27	1.3	nw.	20.4	10
7.36 p. m..	718.7	10.8	58	wnw.	9.4	1,383	647.7	3.6	70	4.3	nw.	21.4	0
7.47 p. m..	718.7	10.8	58	wnw.	9.8	934	684.3	7.4	59	4.7	nw.	20.4	0
7.52 p. m..	718.7	10.8	58	wnw.	9.8	526	718.7	10.8	58	5.7	wnw.	9.8	......
Fourth flight—													
8.32 p. m..	719.0	9.9	63	w.	8.5	526	719.0	9.9	63	5.8	w.	8.5	......
8.40 p. m..	719.1	9.9	63	w.	8.5	933	684.7	8.9	62	5.4	wnw.	16.8	0
8.52 p. m..	719.2	9.9	63	w.	8.5	1,434	644.4	5.1	75	5.1	nw.	17.8	0
8.59 p. m..	719.3	9.9	63	w.	7.6	1,945	605.1	0.5	82	4.1	nw.	21.4	0
9.11 p. m..	719.3	9.8	64	w.	9.4	2,248	582.9	3.7	34	2.1	nnw.	20.4	80
9.19 p. m..	719.4	9.8	64	w.	9.4	2,772	546.5	2.9	32	1.9	nnw.	23.2	180
9.27 p. m..	719.4	9.8	64	w.	10.3	3,383	506.7	0.9	30	1.5	nnw.	26.3	420
9.28 p. m..	719.4	9.8	64	w.	10.3	3,566	495.3	1.1	28	1.5	nnw.	26.3	490
9.36 p. m..	719.4	10.0	62	w.	10.3	3,923	473.8	−1.0	22	1.0	nnw.	25.5	490
9.56 p. m..	719.5	10.0	63	w.	9.4	3,354	509.1	1.0	20	1.0	nnw.	24.5	285
9.58 p. m..	719.5	10.0	63	w.	9.4	3,283	513.6	0.6	21	1.1	nnw.	21.4	260
10.07 p. m..	719.5	9.9	64	w.	8.9	2,961	534.7	2.1	23	1.3	nnw.	21.4	170
10.29 p. m..	719.6	9.9	63	w.	10.7	2,053	597.7	5.7	24	1.7	nw.	20.4	170
10.36 p. m..	719.6	10.0	62	w.	9.4	1,602	631.6	4.3	22	1.4	nw.	22.0	40
10.40 p. m..	719.6	10.0	62	w.	9.8	1,457	643.1	4.9	46	3.1	nw.	21.4	0
10.51 p. m..	719.7	10.0	62	wnw.	8.9	941	684.7	8.2	71	5.9	nw.	17.8	0
11.00 p. m..	719.7	9.7	64	wnw.	7.6	624	711.3	10.9	64	6.3	wnw.	13.9	0
11.02 p. m..	719.7	9.6	65	wnw.	7.6	526	719.7	9.6	65	5.9	wnw.	7.6	......
Fifth flight—													
11.27 p. m..	719.7	9.4	65	wnw.	9.8	526	719.7	9.4	65	5.8	wnw.	9.8	......
11.28 p. m..	719.7	9.4	65	wnw.	9.8	627	711.1	9.9	62	5.7	wnw.	18.8	0
11.37 p. m..	719.8	9.6	64	wnw.	9.8	976	681.8	7.6	72	5.8	nw.	17.8	0
11.48 p. m..	719.8	9.4	65	wnw.	10.3	1,443	644.2	4.8	67	4.5	nw.	20.9	0
Oct. 2, 1912:													
12.01 a. m..	719.8	9.4	65	wnw.	10.3	1,826	614.9	7.0	31	2.4	nw.	11.7	170
12.31 a. m..	719.7	9.5	65	wnw.	13.9	1,542	636.4	9.2	26	2.3	nw.	9.8	170
1.16 a. m..	719.7	8.8	69	wnw.	14.8	1,361	650.6	11.4	22	2.2	nw.	7.6	0
1.38 a. m..	719.8	8.8	70	wnw.	15.6	1,446	644.2	10.7	22	2.1	nw.	8.2	160
1.41 a. m..	719.8	8.8	70	wnw.	15.6	1,661	627.6	10.4	22	2.1	nw.	8.2	170
1.51 a. m..	719.8	8.4	73	wnw.	14.8	1,443	644.2	8.0	21	1.7	nw.	17.4	150
1.55 a. m..	719.8	8.4	73	wnw.	14.8	1,232	660.9	6.5	30	2.2	nw.	24.0	0
2.04 a. m..	719.8	8.6	74	wnw.	13.4	943	684.5	7.9	63	5.1	nw.	22.4	0
2.12 a. m..	719.8	8.4	74	wnw.	12.5	596	713.8	9.2	70	6.2	wnw.	19.2	0
2.14 a. m..	720.0	8.4	74	wnw.	12.1	526	720.0	8.4	74	6.2	wnw.	12.1	......

Third flight: Five kites were used; lifting surface, 32.0 sq. m. Wire out, 4,700 m.; at maximum altitude, 4,650 m.

There were a few Cu., from the northwest, at the beginning of the flight.

Fourth flight: Five kites were used; lifting surface, 32.0 sq. m. Wire out, 5,000 m., at maximum altitude.

The sky was cloudless.

Fifth flight: Six kites were used; lifting surface, 38.3 sq. m. Wire out, 5,800 m.; at maximum altitude, 2,400 m.

There were a few Ci.-Cu. from the northwest, about 1.45 a. m.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Height	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
Oct. 2, 1912:													
Sixth flight—	*mm.*	*°C.*	*%*		*m. p. s.*	*m.*	*mm.*	*°C.*	*%*	*g.cu.m.*		*m. p. s.*	*Volts.*
2.46 a. m.	720.3	8.0	75	nw.	9.4	526	720.3	8.0	75	6.2	nw.	9.4	......
2.47 a. m.	720.3	8.0	75	nw.	9.4	681	706.9	8.2	79	6.6	nw.	17.1	0
2.54 a. m.	720.4	7.8	77	nw.	8.9	935	685.6	6.7	77	5.8	nnw.	17.8	0
3.05 a. m.	720.5	7.8	77	wnw.	8.9	1,452	643.8	4.5	81	5.3	nnw.	22.6	0
3.16 a. m.	720.5	7.6	80	nw.	10.3	1,885	610.7	7.2	40	3.1	nnw.	11.2	260
3.40 a. m.	720.6	7.4	79	nw.	10.3	1,567	634.8	8.1	29	2.4	nw.	8.2	170
3.55 a. m.	720.6	7.4	80	nw.	9.4	2,194	588.3	5.8	29	2.1	nw.	8.2	390
4.22 a. m.	721.0	7.3	78	nw.	9.4	2,460	569.8	5.8	32	2.3	nnw.	10.0	330
4.28 a. m.	721.1	7.3	78	nw.	8.9	2,922	538.5	3.7	31	1.9	nnw.	10.0	......
5.05 a. m.	721.6	6.7	90	nw.	5.4	2,416	573.5	5.6	34	2.4	nw.	8.3	280
5.25 a. m.	721.8	6.4	84	nw.	7.2	1,564	636.1	7.9	29	2.4	nw.	15.3	0
5.30 a. m.	721.8	6.3	85	nw.	6.7	1,334	654.1	5.5	31	2.2	nw.	20.3	0
5.38 a. m.	721.9	6.4	85	wnw.	5.8	1,109	672.4	6.4	71	5.3	nnw.	21.0	0
5.43 a. m.	722.0	6.4	84	wnw.	4.9	968	684.2	5.9	60	4.3	nnw.	15.8	0
5.49 a. m.	722.0	6.2	86	wnw.	4.5	700	706.9	6.9	67	5.1	nw.	13.9	0
5.51 a. m.	722.0	6.2	86	wnw.	4.5	526	722.0	6.2	86	6.3	wnw.	4.5	......
Seventh flight—													
6.20 a. m.	722.3	6.0	87	nw.	4.9	526	722.3	6.0	87	6.3	nw.	4.9	......
6.23 a. m.	722.3	6.1	86	nw.	5.4	616	714.4	6.9	73	5.6	nw.	10.0	0
6.33 a. m.	722.4	6.3	84	nw.	4.5	898	690.4	5.5	71	5.0	nnw.	15.3	0
6.41 a. m.	722.5	6.5	83	nw.	4.9	1,067	677.3	6.3	62	4.6	nnw.	18.0	0
6.45 a. m.	722.6	6.6	82	nw.	4.5	1,314	656.5	5.6	77	5.4	nnw.	19.0	0
6.50 a. m.	722.6	6.7	82	nw.	4.0	1,428	647.5	6.4	39	2.9	nnw.	15.8	0
7.05 a. m.	722.7	6.6	84	nw.	4.9	1,544	638.5	7.3	31	2.4	nw.	10.2	0
7.08 a. m.	722.7	6.7	83	nw.	4.9	1,810	618.2	7.1	31	2.4	nw.	11.7	10
7.31 a. m.	722.8	8.0	75	nw.	3.6	2,373	577.3	4.6	33	2.2	nw.	12.2	170
8.05 a. m.	722.9	9.2	69	nw.	2.2	2,460	571.3	4.3	37	2.4	nw.	10.7	......
8.27 a. m.	722.9	9.2	72	nnw.	2.7	2,723	553.3	3.1	38	2.3	nw.	14.1	......
8.38 a. m.	722.8	9.2	71	n.	2.2	1,981	605.7	6.4	39	2.9	wnw.	9.5	0
8.46 a. m.	722.8	9.2	69	nnw.	2.2	1,448	646.2	7.9	37	3.0	nw.	9.4	0
8.55 a. m.	722.8	9.2	68	nnw.	1.8	763	702.3	5.7	57	4.0	nnw.	....	0
8.58 a. m.	722.8	9.2	67	nw.	1.8	526	722.8	9.2	67	5.9	nw.	1.8	......
Eighth flight—													
10.24 a. m.	722.6	11.1	51	nnw.	1.8	526	722.6	11.1	51	5.1	nnw.	1.8	......
10.36 a. m.	722.5	11.7	49	w.	1.8	2,303	583.0	7.0	......	....	wnw.	....	......
10.40 a. m.	722.5	11.8	51	w.	1.8	1,882	613.5	9.0	......	....	wnw.	....	......
11.01 a. m.	722.4	13.1	56	w.	1.8	1,107	673.6	7.1	......	....	wnw.	....	......
11.41 a. m.	722.0	14.1	55	s.	1.3	807	698.3	10.0	......	....	wsw.	....	......
11.55 a. m.	721.8	13.9	52	w.	1.8	526	721.8	13.9	52	6.2	w.	1.8	......

October 2, 1912.—Sixth flight: Seven kites were used; lifting surface, 44.6 sq. m. Wire out, 6,500 m.; at maximum altitude, 5,900 m.

There were 3/10 A.-St., from the north-northwest, during the latter part of the flight.

Seventh flight: Five kites were used; lifting surface, 33.5 sq. m. Wire out, 4,100 m.; at maximum altitude, 3,200 m.

There were 6/10 Ci. and Ci.-St., from the west.

High pressure (770 mm.) was central over northern Virginia, low pressure (752 mm.) over New Brunswick.

Eighth flight: One captive balloon was used; capacity, 28.7 cu. m. Wire out, 3,000 m.

Ci., from the west, diminished from 5/10 to few.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Height	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
Oct. 2, 1912: *Ninth flight*—	*mm.*	*°C.*	%		*m. p. s.*	*m.*	*mm.*	*°C.*	%	*g.cu.m.*		*m. p. s.*	*Volts.*
12.53 p. m.	721.2	15.2	50	wsw.	1.8	526	721.2	15.2	50	6.4	wsw.	1.8	......
1.03 p. m.	721.1	15.2	53	se.	1.8	2,063	599.7	8.8	......	......	w.	......	......
1.10 p. m.	721.0	14.8	54	se.	1.8	1,408	648.8	7.4	......	......	w.	......	......
1.25 p. m.	720.9	14.9	54	e.	2.2	1,383	650.8	9.6	......	......	w.	......	......
1.54 p. m.	720.6	16.2	55	sse.	3.1	853	693.3	11.8	......	......	sse.	......	......
1.59 p. m.	720.6	16.2	55	se.	3.1	526	720.6	16.2	55	7.5	se.	3.1	......
Oct. 4, 1912:													
8.21 a. m.	717.0	17.8	60	sw.	4.9	526	717.0	17.8	60	9.0	sw.	4.9	......
8.58 a. m.	717.0	18.3	60	w.	6.7	1,011	677.5	15.7	64	8.5	nw.	11.4	0
9.06 a. m.	717.0	18.3	60	w.	7.6	1,229	660.4	14.8	62	7.8	nw.	11.2	0
10.06 a. m.	717.0	19.0	63	w.	5.8	1,467	642.3	14.3	58	7.1	nw.	5.2	0
10.15 a. m.	717.0	19.2	64	wnw.	5.4	1,216	661.7	15.9	57	7.7	wnw.	10.2	0
10.27 a. m.	717.0	19.4	58	w.	5.4	815	693.4	18.3	63	9.8	nw.	10.2	0
10.32 a. m.	717.0	19.4	60	w.	4.9	526	717.0	19.4	60	10.0	w.	4.9	......
Oct. 7, 1912: *First flight*—													
8.40 a. m.	714.6	16.4	70	w.	5.8	526	714.6	16.4	70	9.7	w.	5.8	......
8.46 a. m.	714.5	16.8	69	wnw.	6.3	845	688.4	17.5	69	10.2	nw.	14.9	0
8.51 a. m.	714.5	17.0	69	wnw.	5.8	929	681.7	17.2	67	9.7	nw.	18.9	0
9.03 a. m.	714.4	17.3	68	wnw.	6.7	1,296	652.9	15.2	66	8.5	nnw.	14.3	0
9.12 a. m.	714.4	17.6	68	w.	7.6	1,397	645.2	16.3	46	6.3	nnw.	8.2	0
10.24 a. m.	714.2	19.5	63	w.	6.7	1,601	629.8	14.6	46	5.7	n.	11.2	0
10.27 a. m.	714.2	19.6	63	w.	7.6	1,913	607.0	12.5	53	5.8	n.	11.2	0
10.29 a. m.	714.2	19.6	62	w.	7.6	2,354	576.0	12.5	42	4.6	nnw.	18.9	0
10.39 a. m.	714.1	19.9	61	w.	7.2	3,621	494.2	3.8	29	1.8	nw.	10.7	0
10.57 a. m.	713.9	20.2	59	w.	7.6	3,863	479.4	1.4	18	1.0	nw.	13.8	......
11.04 a. m.	713.9	20.0	59	w.	8.9	3,549	497.6	3.2	16	1.0	nw.	13.8	0
11.11 a. m.	713.8	20.1	59	w.	9.8	3,413	505.8	2.5	14	0.8	nw.	16.9	0
11.23 a. m.	713.6	20.2	60	w.	9.8	2,991	532.6	5.5	30	2.1	nw.	18.0	0
11.33 a. m.	713.5	20.6	61	w.	11.6	2,397	572.3	8.8	38	3.3	nnw.	16.8	0
11.35 a. m.	713.5	20.6	61	w.	10.3	2,310	578.4	8.8	42	3.6	nnw.	11.7	0
11.43 a. m.	713.4	20.9	60	wnw.	10.3	1,525	634.9	15.1	49	6.3	n.	7.2	0
11.59 a. m.	713.2	21.5	60	w.	8.9	1,150	663.3	17.3	66	9.6	nnw.	15.3	0
12.04 p. m.	713.2	21.6	61	w.	9.4	999	675.1	16.4	66	7.1	nw.	18.7	0
12.10 p. m.	713.1	21.5	59	w.	10.3	881	684.4	17.0	68	9.7	wnw.	17.3	0
12.20 p. m.	713.0	21.4	59	wnw.	9.4	526	713.0	21.4	59	11.0	wnw.	9.4	......

Ninth flight: One captive balloon was used; capacity, 28.7 cu. m. Wire out, 2,500 m. There were a few Ci. from the west.

October 4, 1912.—Four kites were used; lifting surface, 27.7 sq. m. Wire out, 2,500 m.; at maximum altitude, 2,400 m.

The sky was cloudless.

High pressure (764 mm.) was central over Virginia, and low pressure (753 mm.) was central over the lower St. Lawrence Valley.

October 7, 1912.—*First flight:* Seven kites were used; lifting surface, 46.6 sq. m. Wire out, 5,800 m.; at maximum altitude, 4,700 m.

The sky was cloudless.

At 8 a. m. low pressure was central over the lower St. Lawrence (747 mm.) and east of the South Atlantic coast (749 mm.). High pressure (772 mm.) was central over South Dakota.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Height	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
Oct. 7, 1912:													
Second flight—	*mm.*	*°C.*	*%*		*m. p. s.*	*m.*	*mm.*	*°C.*	*%*	*g.cu.m.*		*m. p. s.*	*Volts.*
12.49 p. m..	712.2	22.2	61	wnw.	11.6	526	712.2	22.2	61	11.9	wnw.	11.6	......
12.56 p. m..	712.6	22.2	60	wnw.	10.7	838	687.5	19.2	61	10.0	wnw.	16.3	0
1.13 p. m..	712.5	22.6	59	wnw.	9.8	971	676.9	20.5	59	10.4	nw.	13.6	0
1.18 p. m..	712.4	22.6	58	wnw.	9.8	1,310	650.7	18.5	60	9.4	nw.	11.1	0
1.55 p. m..	712.1	23.6	56	w.	6.7	2,003	599.8	14.8	50	6.3	nw.	7.6	0
2.09 p. m..	712.1	23.8	57	w.	6.3	3,491	501.3	1.7	64	3.5	nw.	22.8	0
2.11 p. m..	712.1	23.8	57	w.	6.3	3,663	490.8	1.5	59	3.2	nw.	22.8	0
2.19 p. m..	712.0	23.9	57	w.	6.3	4,081	464.8	−1.6	37	1.6	nw.	19.5	......
2.48 p. m..	711.9	23.9	59	w.	6.7	3,277	512.8	1.7	73	4.0	nw.	19.0	0
2.51 p. m..	711.9	23.8	59	w.	5.8	3,202	517.4	1.8	74	4.0	nw.	16.9	0
2.57 p. m..	711.9	23.7	60	w.	4.0	2,913	536.3	3.5	76	4.7	nw.	16.0	0
3.11 p. m..	711.9	23.7	60	wsw.	5.8	2,604	556.8	6.3	72	5.3	nw.	23.2	0
3.21 p. m..	711.9	24.4	57	w.	5.4	1,902	606.0	11.1	72	7.2	nw.	22.4	0
3.26 p. m..	711.9	24.7	58	w.	4.9	1,645	625.0	11.0	84	8.3	wnw.	14.3	0
3.28 p. m..	711.9	24.6	58	w.	4.9	1,748	617.4	10.4	88	8.4	wnw.	20.4	0
3.36 p. m..	711.8	24.6	57	wsw.	5.4	1,386	644.3	14.0	80	9.6	wnw.	16.3	0
3.49 p. m..	711.8	24.4	56	wsw.	6.3	898	682.2	19.7	68	11.4	wnw.	10.8	0
3.55 p. m..	711.8	24.2	56	w.	5.4	526	711.8	24.2	56	12.2	w.	5.4	......
Third flight—													
4.22 p. m..	711.8	23.0	63	wnw.	8.0	526	711.8	23.0	63	12.8	wnw.	8.0	......
4.28 p. m..	711.8	22.8	64	wnw.	6.3	923	680.2	21.8	72	13.7	nw.	15.8	0
4.42 p. m..	711.7	22.7	64	wnw.	9.8	1,260	654.0	18.5	83	13.0	nw.	14.8	0
4.53 p. m..	711.7	22.2	66	wnw.	10.3	1,603	628.3	15.4	91	11.9	nw.	11.7	0
5.19 p. m..	711.8	21.2	69	wnw.	10.3	1,969	601.7	13.4	76	8.8	wnw.	16.4	0
5.30 p. m..	711.8	20.8	71	wnw.	11.6	2,892	538.2	4.7	80	5.3	wnw.	26.0	0
5.35 p. m..	711.9	20.6	72	wnw.	10.7	3,464	502.0	1.7	56	3.0	wnw.	23.9	0
5.41 p. m..	711.9	20.3	73	wnw.	9.4	3,559	495.0	2.6	45	2.6	wnw.	......	......
5.44 p. m..	711.9	20.1	74	wnw.	10.7	3,485	498.5	2.8	39	2.3	wnw.	22.4	......
5.46 p. m..	712.0	19.9	75	wnw.	10.7	3,451	500.8	2.6	36	2.1	wnw.	23.5	......
6.13 p. m..	712.1	19.0	79	wnw.	9.8	2,937	533.4	4.7	32	2.1	wnw.	21.0	0
6.18 p. m..	712.2	18.9	80	wnw.	9.8	2,667	551.4	4.8	48	3.2	wnw.	20.4	0
6.34 p. m..	712.3	18.6	81	wnw.	10.7	1,792	613.0	9.5	80	7.2	wnw.	19.4	0
6.48 p. m..	712.5	18.2	80	wnw.	10.7	1,271	652.7	11.6	86	8.9	nw.	25.5	0
6.58 p. m..	712.6	17.9	82	wnw.	11.6	890	682.9	14.4	82	10.0	nw.	24.5	0
7.07 p. m..	712.7	17.8	81	wnw.	9.8	526	712.7	17.8	81	12.2	wnw.	9.8	......
Fourth flight—													
7.41 p. m..	713.0	16.4	77	wnw.	8.9	526	713.0	16.4	77	10.7	wnw.	8.9	......
7.50 p. m..	713.1	16.0	79	wnw.	10.3	884	683.7	13.8	87	10.3	nnw.	18.9	0
8.01 p. m..	713.2	15.6	77	nw.	11.6	1,382	644.5	12.0	84	8.9	nw.	18.4	0
8.16 p. m..	713.3	15.6	72	wnw.	10.3	1,843	610.0	10.1	39	3.7	nw.	21.6	0
8.21 p. m..	713.3	15.4	74	wnw.	10.3	2,050	595.0	11.7	31	3.2	nw.	21.1	110
8.25 p. m..	713.4	15.2	75	wnw.	11.2	2,585	558.2	10.5	27	2.6	nw.	20.4	330
8.27 p. m..	713.4	15.1	75	wnw.	11.2	2,731	548.5	10.7	26	2.5	nw.	21.4	330
8.36 p. m..	713.4	14.8	76	wnw.	9.8	3,515	499.1	8.0	21	1.7	wnw.	23.7	430
8.38 p. m..	713.5	14.8	76	wnw.	9.8	3,711	487.7	7.8	21	1.7	wnw.	23.7	460
8.45 p. m..	713.5	14.8	75	wnw.	9.8	4,060	466.2	4.4	20	1.3	wnw.	23.5	......
9.02 p. m..	713.6	14.3	73	wnw.	12.5	3,561	494.5	6.3	18	1.3	nw.	22.3	400
9.04 p. m..	713.6	14.2	73	wnw.	12.5	3,464	500.3	5.9	17	1.2	nw.	23.3	390
9.11 p. m..	713.7	13.9	73	wnw.	9.4	3,053	525.9	7.0	15	1.2	nw.	24.3	335
9.18 p. m..	713.8	13.8	74	wnw.	8.5	2,726	547.2	6.7	13	1.0	nw.	22.6	320
9.28 p. m..	713.8	13.7	70	wnw.	8.5	2,036	595.0	8.5	13	1.1	nw.	23.1	50
9.30 p. m..	713.8	13.6	70	wnw.	8.5	1,949	601.2	8.1	13	1.1	nw.	22.1	10
9.36 p. m..	713.9	13.4	69	wnw.	7.6	1,880	606.2	8.1	15	1.2	nw.	21.4	0
9.38 p. m..	713.9	13.4	69	wnw.	7.6	1,831	610.0	7.3	21	1.6	nw.	20.5	0
9.40 p. m..	713.9	13.4	70	wnw.	7.2	1,762	615.1	7.2	25	2.0	nw.	20.5	0
9.42 p. m..	714.0	13.2	70	wnw.	7.2	1,627	625.2	5.9	30	2.2	nw.	17.0	0
9.50 p. m..	714.0	13.0	71	wnw.	10.3	1,214	657.4	7.2	90	7.0	nw.	17.3	0
10.00 p. m..	714.1	12.8	70	wnw.	8.9	890	683.7	9.6	80	7.3	nnw.	18.4	0
10.08 p. m..	714.2	12.6	71	wnw.	8.5	526	714.2	12.6	71	7.8	wnw.	8.5	......

Second flight: Seven kites were used; lifting surface, 46.1 sq. m. Wire out, 6,000 m.; at maximum altitude, 5,800 m.

After 2.30 p. m. there were from 1/10 to 2/10 St.-Cu. from the northwest.

Third flight: Six kites were used; lifting surface, 39.8 sq. m. Wire out, 5,000 m., at maximum altitude.

St.-Cu. from the northwest before and from the west-northwest after 5 p. m. decreased from 10/10 to 1/10. The head kite was in St.-Cu., altitude 2,800 m., at 5.24 p. m.

Fourth flight: Five kites were used; lifting surface, 31.5 sq. m. Wire out, 5,200 m., at maximum altitude.

There were 1/10 St.-Cu. from the northwest after 9.20 p. m.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Height	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
Oct. 7, 1912:													
Fifth flight—	*mm.*	*°C.*	*%*		*m. p. s.*	*m.*	*mm.*	*°C.*	*%*	*g. cu. m.*		*m. p. s.*	*Volts.*
10.38 p. m.	714.4	12.0	74	wnw.	8.9	526	714.4	12.0	74	7.8	wnw.	8.9	......
10.46 p. m.	714.4	11.6	76	wnw.	8.0	909	682.4	8.8	80	6.9	nnw.	15.8	0
10.55 p. m.	714.5	11.4	76	wnw.	11.2	1,267	653.5	6.4	92	6.8	nnw.	11.7	0
11.04 p. m.	714.5	11.0	76	wnw.	11.6	1,499	635.4	10.0	54	5.0	nnw.	15.3	0
11.09 p. m.	714.5	10.9	76	nw.	9.8	2,045	594.9	8.8	36	3.1	nnw.	18.4	0
11.26 p. m.	714.5	10.6	75	nw.	13.9	2,525	561.6	11.0	23	2.3	nnw.	15.3	0
11.42 p. m.	714.4	10.1	76	nw.	9.8	3,068	525.7	7.1	15	1.2	nnw.	13.0	......
Oct. 8, 1912:													
12.34 a. m.	714.6	9.0	76	nw.	15.2	2,554	559.2	8.7	8	0.7	nnw.	8.8	0
1.06 a. m.	714.7	8.6	74	nw.	10.7	2,339	573.8	11.8	6	0.6	nnw.	10.3	0
1.08 a. m.	714.7	8.6	74	nw.	8.9	2,249	580.0	11.8	6	0.6	nnw.	12.2	0
1.13 a. m.	714.7	8.4	74	nw.	10.3	2,039	591.2	10.6	5	0.5	nnw.	15.5	0
1.15 a. m.	714.7	8.4	74	nw.	10.3	1,984	598.6	10.8	4	0.4	nnw.	15.8	0
1.27 a. m.	714.7	8.3	74	nw.	10.3	1,491	635.4	6.6	6	0.5	nnw.	20.4	0
1.32 a. m.	714.8	8.3	74	nw.	11.2	1,132	664.0	4.0	18	1.1	nnw.	20.9	0
1.37 a. m.	714.8	8.2	73	nw.	13.9	877	685.1	5.7	54	3.8	nnw.	20.4	0
1.43 a. m.	714.8	8.2	73	nw.	13.0	830	689.0	6.0	76	5.5	nnw.	21.2	0
1.50 a. m.	714.8	7.8	75	nw.	14.8	526	714.8	7.8	75	6.1	nw.	14.8	......
Sixth flight—													
2.23 a. m.	714.9	7.4	74	nw.	10.3	526	714.9	7.4	74	5.8	nw.	10.3	......
2.32 a. m.	714.9	7.4	74	nw.	11.6	881	684.7	5.3	82	5.7	n.	22.1	0
2.35 a. m.	714.9	7.4	74	nw.	13.0	1,009	674.1	4.6	71	4.7	nnw.	25.7	0
2.37 a. m.	714.9	7.4	74	nw.	13.0	1,317	649.3	9.1	44	3.9	nnw.	20.4	0
2.39 a. m.	714.9	7.4	74	nw.	9.8	1,450	639.1	9.0	38	3.3	nnw.	21.4	0
2.42 a. m.	714.9	7.3	73	nw.	10.3	1,499	635.2	9.5	33	3.0	nnw.	21.4	0
2.46 a. m.	715.0	7.1	75	nw.	10.3	1,602	627.5	9.1	28	2.5	nnw.	18.8	0
2.50 a. m.	715.0	7.0	77	nw.	9.4	2,030	596.1	12.3	26	2.8	nnw.	11.7	0
3.41 a. m.	715.2	6.4	78	nw.	12.1	2,779	544.9	7.8	18	1.5	nnw.	12.8	355
3.45 a. m.	715.2	6.4	77	nw.	11.6	3,167	519.9	6.2	17	1.2	nw.	17.3	510
3.50 a. m.	715.3	6.4	76	nw.	8.0	3,466	501.4	6.6	16	1.2	nw.	18.7	......
3.57 a. m.	715.3	6.3	76	nw.	8.9	3,763	483.1	5.7	15	1.1	nw.	21.2	......
4.05 a. m.	715.3	6.3	78	nw.	8.5	3,650	490.0	5.1	13	0.9	nw.	18.7	......
4.06 a. m.	715.4	6.2	79	nw.	8.5	3,575	494.5	5.2	12	0.8	nw.	17.2	......
4.08 a. m.	715.4	6.2	79	nw.	8.5	3,461	501.4	5.1	12	0.8	nw.	15.1	......
4.16 a. m.	715.4	6.3	76	nw.	8.9	3,015	529.4	6.4	14	1.0	nw.	15.4	250
4.33 a. m.	715.6	6.2	75	nw.	11.0	2,406	570.2	8.3	17	1.4	nnw.	12.0	80
4.47 a. m.	715.7	6.1	76	nw.	9.4	1,659	623.7	12.0	20	2.1	nnw.	11.9	0
4.52 a. m.	715.7	6.0	76	nw.	10.3	1,224	657.1	6.3	18	1.3	nnw.	17.3	0
4.57 a. m.	715.8	6.0	76	nw.	9.4	1,209	658.4	7.8	19	1.5	nnw.	21.3	0
4.59 a. m.	715.8	6.0	76	nw.	11.6	1,048	671.5	3.1	25	1.5	nnw.	15.2	0
5.07 a. m.	715.9	6.1	74	nw.	9.8	891	684.7	4.0	72	4.6	nnw.	18.5	0
5.13 a. m.	716.0	6.0	76	nw.	12.1	526	716.0	6.0	76	5.5	nw.	12.1	......

Fifth flight: Six kites were used; lifting surface, 37.8 sq. m. Wire out, 6,000 m.; at maximum altitude, 3,900 m.

1/10 St.-Cu. from the north-northwest disappeared before 12 midnight.

October 8, 1912.—Sixth flight: Six kites were used; lifting surface, 38.8 sq. m. Wire out, 5,800 m.; at maximum altitude, 5,200 m.

The sky was cloudless.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Height	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
Oct. 8, 1912:													
Seventh flight—	*mm.*	*°C.*	*%*		*m. p. s.*	*m.*	*mm.*	*°C.*	*%*	*g.cu.m.*		*m. p. s.*	*Volts.*
5.42 a. m.	716.4	5.8	79	nw.	8.9	526	716.4	5.8	79	5.6	nw.	8.9	......
5.54 a. m.	716.6	5.7	77	nw.	11.2	927	682.3	3.6	82	5.1	n.	17.7	0
5.59 a. m.	716.7	5.6	79	nw.	11.6	1,100	667.9	2.4	81	4.6	nnw.	17.2	0
6.03 a. m.	716.7	5.6	79	nw.	11.6	1,440	640.8	9.3	45	4.0	nnw.	17.3	0
6.14 a. m.	716.8	5.4	78	nw.	11.6	1,572	630.7	10.0	31	2.9	nnw.	10.2	0
6.16 a. m.	716.8	5.4	78	nw.	13.0	1,779	615.5	10.3	29	2.8	nnw.	9.2	0
6.18 a. m.	716.8	5.4	78	nw.	12.1	1,947	603.0	9.9	29	2.7	nw.	9.2	0
7.12 a. m.	717.3	5.6	74	nw.	8.0	2,352	574.7	8.1	22	1.8	nw.	9.4	260
7.23 a. m.	717.5	5.6	76	nw.	8.0	3,361	508.5	6.7	18	1.4	nw.	18.9	330
7.28 a. m.	717.6	5.8	76	nw.	7.2	3,264	514.3	6.2	15	1.1	nw.	17.1	300
7.38 a. m.	717.7	6.1	74	nw.	6.3	2,333	575.9	7.6	17	1.4	nw.	10.4	0
7.52 a. m.	718.0	6.2	74	nw.	6.0	2,094	593.1	7.6	20	1.6	nnw.	10.6	0
7.56 a. m.	718.0	6.3	74	nw.	6.3	1,854	610.5	8.5	21	1.8	n.	13.3	0
8.04 a. m.	718.1	6.4	75	nw.	5.8	1,552	633.2	7.3	23	1.8	n.	14.3	0
8.10 a. m.	718.1	6.4	72	nw.	7.2	1,053	673.1	2.5	27	1.5	n.	14.3	0
8.15 a. m.	718.2	6.6	72	nw.	5.8	929	683.6	2.9	52	3.1	n.	12.6	0
8.22 a. m.	718.2	6.6	72	nw.	6.7	526	718.2	6.6	72	5.4	nw.	6.7	......
Oct. 9, 1912:													
8.36 a. m.	720.3	10.2	73	sse.	8.5	526	720.3	10.2	73	6.9	sse.	8.5	......
8.39 a. m.	720.3	10.3	73	sse.	8.5	658	708.9	8.8	72	6.2	ssw.	16.3	0
8.57 a. m.	720.3	10.8	72	se.	9.8	977	682.4	12.4	54	5.9	ssw.	10.6	0
10.03 a. m.	720.3	12.6	65	se.	11.6	1,077	674.5	18.2	34	5.2	ssw.	5.0	0
10.15 a. m.	720.3	12.2	67	se.	9.8	1,274	659.0	16.9	34	4.8	ssw.	6.3	......
10.24 a. m.	720.2	12.4	66	se.	9.4	881	690.3	10.2	52	4.9	ssw.	11.2	0
10.26 a. m.	720.2	12.3	67	sse.	9.4	526	720.2	12.3	67	7.2	sse.	9.4	......
Oct. 10, 1912:													
8.20 a. m.	718.8	20.4	66	w.	9.8	526	718.8	20.4	66	11.6	w.	9.8	......
8.22 a. m.	718.8	20.4	66	w.	8.5	724	702.7	21.2	64	11.7	wnw.	......	0
8.32 a. m.	718.9	20.6	67	w.	8.5	1,008	680.1	20.2	64	11.1	w.	18.9	0
8.47 a. m.	719.0	20.7	67	w.	8.9	1,467	645.0	18.4	64	10.0	wnw.	19.9	0
8.58 a. m.	719.1	21.2	65	w.	8.9	1,866	615.8	15.9	61	8.2	wnw.	13.3	0
9.06 a. m.	719.1	21.4	65	w.	8.9	1,953	609.5	16.1	59	8.0	wnw.	12.4	0
9.13 a. m.	719.1	21.6	65	w.	8.9	2,484	572.4	13.6	44	5.1	wnw.	16.8	0
9.27 a. m.	719.1	21.6	65	w.	7.2	2,921	543.5	9.0	45	3.9	wnw.	16.3	0
9.45 a. m.	719.2	21.9	64	w.	6.7	3,809	487.8	2.4	56	3.2	wnw.	27.5	0
9.47 a. m.	719.2	21.9	65	w.	6.7	3,886	483.2	2.8	48	2.8	wnw.	25.5	0
9.53 a. m.	719.2	21.8	65	w.	6.3	4,022	474.3	2.5	27	1.5	wnw.	23.2	......
9.58 a. m.	719.2	22.0	65	w.	6.7	3,861	483.2	1.2	26	1.4	wnw.	23.1	0
10.08 a. m.	719.2	22.4	65	w.	6.3	3,157	527.0	3.8	54	3.4	wnw.	19.9	0
10.23 a. m.	719.2	23.2	62	w.	5.4	2,441	574.9	9.9	50	4.6	wnw.	18.4	0
10.40 a. m.	719.2	23.0	61	w.	5.4	1,846	617.0	14.7	55	6.9	wnw.	15.8	0
10.43 a. m.	719.2	23.1	61	w.	5.4	1,742	624.6	14.0	56	6.7	wnw.	13.9	0
10.52 a. m.	719.2	23.2	62	w.	5.8	1,399	650.2	17.0	56	8.0	wnw.	19.4	0
11.03 a. m.	719.2	23.6	62	w.	5.8	895	689.4	20.6	57	10.1	wnw.	13.3	0
11.10 a. m.	719.2	23.8	62	w.	5.4	526	719.2	23.8	62	.13.2	w.	5.4	......

Seventh flight: Six kites were used; lifting surface, 38.3 sq. m. Wire out, 5,800 m.; at maximum altitude, 4,400 m.

There were a few Ci., Ci.-St., and Ci.-Cu. from the northwest.

At 8. a. m., high pressure (766 mm.) was central over the upper Ohio Valley. Pressure was low over Newfoundland (751 mm.) and east of the South Atlantic coast (759 mm.).

October 9, 1912.—Five kites were used; lifting surface, 32.0 sq. m. Wire out, 4,200 m.; at maximum altitude, 1,300 m.

There were 5/10 to 3/10 A.-Cu. from the west.

High pressure (768 mm.) was central over Virginia. Low pressure (754 mm.) was central over Missouri.

Oct. 10, 1912.—Six kites were used; lifting surface, 39.8 sq. m. Wire out, 5,400 m.; at maximum altitude, 5,100 m.

Ci., Ci.-Cu., and A.-Cu. from the west decreased from 4/10 to 2/10.

High pressure (768 mm.) central over Western North Carolina covered the eastern half of the United States.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Height	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
Oct. 15, 1912:													
First flight—	*mm.*	*°C.*	*%*		*m. p. s.*	*m.*	*mm.*	*°C.*	*%*	*g.cu.m.*		*m. p. s.*	*Volts.*
8.07 a. m..	720.5	9.6	68	wnw.	10.3	526	720.5	9.6	68	6.2	wnw.	10.3	......
8.09 a. m..	720.5	9.6	68	wnw.	10.3	677	707.6	10.1	65	6.1	wnw.	20.9	0
8.10 a. m..	720.5	9.6	68	wnw.	10.3	837	694.2	11.1	58	5.8	nw.	20.9	0
8.20 a. m..	720.5	9.2	67	wnw.	12.1	1,369	651.1	8.6	51	4.4	nw.	23.1	0
8.30 a. m..	720.6	9.6	67	wnw.	12.1	1,755	621.7	10.4	23	2.2	nw.	19.2	250
8.45 a. m..	720.6	10.2	59	wnw.	11.2	2,372	577.1	6.2	23	1.7	nw.	23.5	680
8.54 a. m..	720.6	10.5	59	wnw.	11.6	2,972	536.3	4.0	28	1.8	nw.	26.8	930
8.56 a. m..	720.6	10.6	59	wnw.	11.6	3,023	532.8	5.1	25	1.7	nw.	25.8	950
9.15 a. m..	720.5	11.5	56	wnw.	12.1	3,730	487.7	0.8	12	0.6	nw.	25.0	1,140
9.39 a. m..	720.4	12.3	52	wnw.	10.7	2,786	546.9	4.5	7	0.5	nw.	24.5	740
9.46 a. m..	720.4	12.6	50	wnw.	10.7	2,333	578.3	3.3	9	0.5	nw.	26.5	550
10.07 a. m..	720.3	12.9	53	w.	8.5	1,624	630.6	6.0	41	2.4	nw.	......	360
10.12 a. m..	720.3	13.2	53	w.	7.6	1,461	643.4	4.2	52	3.3	nw.	19.2	0
10.29 a. m..	720.2	13.2	49	w.	9.8	977	682.3	7.9	58	4.7	nw.	15.6	0
10.35 a. m..	720.2	13.4	50	wnw.	8.9	526	720.2	13.4	50	5.8	wnw.	8.9	......
Second flight—													
11.07 a. m..	720.1	14.6	50	wnw.	9.8	526	720.1	14.6	50	6.2	wnw.	9.8	......
11.18 a. m..	720.0	15.0	48	wnw.	9.4	915	687.5	10.5	54	5.2	nw.	16.8	0
11.45 a. m..	719.8	15.2	49	wnw.	15.6	1,531	638.0	5.6	64	4.5	nw.	23.1	260
11.54 a. m..	719.7	15.2	47	wnw.	16.5	1,863	612.6	3.7	66	4.1	nw.	23.5	380
12.08 p. m..	719.7	15.6	45	wnw.	17.9	2,512	565.7	......	22	......	nw.	28.5	755
12.18 p. m..	719.6	15.7	47	wnw.	13.4	3,079	527.5	......	17	......	nw.	32.6	700
12.34 p. m..	719.5	16.2	44	wnw.	14.8	2,756	548.9	......	11	......	nw.	31.4	630
1.00 p. m..	719.3	16.6	43	wnw.	14.3	2,024	600.1	2.2	23	1.3	nw.	23.6	290
1.14 p. m..	719.3	16.5	42	wnw.	12.1	1,409	647.0	6.2	53	3.9	nw.	18.2	0
1.24 p. m..	719.2	16.3	43	wnw.	13.9	874	690.1	10.9	52	5.1	nw.	18.9	0
1.33 p. m..	719.2	16.7	45	wnw.	11.2	526	719.2	16.7	45	6.3	wnw.	11.2	......
Third flight—													
2.11 p. m..	719.1	16.5	44	wnw.	12.1	526	719.1	16.5	44	6.1	wnw.	12.1	......
2.21 p. m..	719.1	15.9	44	wnw.	13.0	854	691.8	13.0	45	5.1	nw.	16.0	0
2.34 p. m..	719.1	16.3	39	wnw.	14.8	1,358	651.3	8.7	50	4.3	nw.	18.4	0
2.51 p. m..	719.1	16.0	42	wnw.	14.3	2,106	594.4	2.9	32	1.9	nw.	24.5	430
2.55 p. m..	719.1	16.1	40	wnw.	14.8	2,435	571.0	6.1	27	2.0	nw.	......	570
3.15 p. m..	719.3	16.1	39	wnw.	14.8	3,047	529.2	3.7	11	0.7	nw.	......	860
3.47 p. m..	719.7	15.8	41	wnw.	10.3	2,307	579.6	......	7	......	nw.	24.0	0
4.00 p. m..	719.9	15.5	43	wnw.	9.8	1,922	608.0	......	42	......	nw.	17.4	0
4.14 p. m..	719.9	15.1	44	wnw.	12.1	1,343	652.6	6.1	57	4.1	nw.	16.4	0
4.23 p. m..	720.0	14.9	46	wnw.	11.6	957	683.9	9.0	55	4.8	nw.	12.4	0
4.35 p. m..	720.0	14.5	48	wnw.	11.6	526	720.0	14.5	48	5.9	wnw.	11.6	......
Fourth flight—													
5.21 p. m..	720.4	13.3	49	wnw.	10.3	526	720.4	13.3	49	5.6	wnw.	10.3	......
5.30 p. m..	720.6	12.7	53	nw.	9.4	954	684.8	11.2	52	5.2	nw.	17.3	0
5.45 p. m..	720.8	12.7	51	nw.	8.9	1,458	644.6	6.7	64	4.8	nw.	18.5	0
5.56 p. m..	721.0	12.2	50	nw.	10.3	1,918	609.3	2.6	70	4.0	nw.	18.4	340
6.18 p. m..	721.2	11.9	51	nw.	12.1	2,568	562.8	6.6	23	1.7	nw.	23.0	890
6.34 p. m..	721.2	11.8	48	nw.	12.1	3,322	513.4	4.2	14	0.9	nw.	21.9	920
8.14 p. m..	722.2	9.0	60	nw.	10.7	526	722.2	9.0	60	5.3	nw.	10.7	......

October 15, 1912.—First flight: Four kites were used; lifting surface, 25.2 sq. m. Wire out, 5,000 m., at maximum altitude.

A.-Cu., from the west, diminished from 1/10 to a few.

At 8 a. m., high pressure (775 mm.) was central over Minnesota and low pressure (754 mm.) over the lower St. Lawrence Valley.

Second flight: Four kites were used; lifting surface, 25.2 sq. m. Wire out, 5,000 m., at maximum altitude.

There were a few A.-Cu. from the west until about 11.30 a. m., and a few Cu. from the northwest thereafter.

Third flight: Four kites were used; lifting surface, 24.3 sq. m. Wire out, 5,500 m , at maximum altitude.

The sky was cloudless.

Fourth flight: Four kites were used; lifting surface, 23.4 sq. m. Wire out, 5,500 m.; at maximum altitude, 5,300 m.

The sky was cloudless.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Height	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
Oct. 15, 1912:													
Fifth flight—	*mm.*	*°C.*	*%*		*m. p. s.*	*m.*	*mm.*	*°C.*	*%*	*g.cu.m.*		*m. p. s.*	*Volts.*
8.51 p. m..	722.5	8.4	62	nw.	15.2	526	722.5	8.4	62	5.2	nw.	15.2	......
8.59 p. m..	722.5	8.6	57	nw.	12.5	934	687.6	6.2	65	4.8	nnw.	20.5	30
9.05 p. m..	722.5	8.4	59	nw.	8.9	1,494	642.1	3.7	62	3.8	nnw.	15.8	305
9.16 p. m..	722.7	8.4	59	nw.	13.4	1,841	615.4	3.3	37	2.2	nw.	14.0	260
9.25 p. m	722.8	8.3	59	nw.	9.8	1,976	605.4	6.8	24	1.8	nw.	25.0	310
9.30 p. m..	722.8	8.0	61	nw.	10.3	2,494	568.6	6.8	22	1.7	nw.	19.5	515
9.36 p. m..	722.8	7.6	65	nw.	9.8	2,903	540.9	4.7	17	1.1	nw.	21.4	545
10.02 p. m..	723.1	7.3	64	nw.	9.8	3,562	499.0	2.8	14	0.8	nw.	17.5	680
10.18 p. m..	723.2	6.8	68	nw.	8.5	3,084	529.2	3.0	14	0.8	nnw.	15.4	500
10.38 p. m..	723.2	6.2	70	nw.	9.8	2,135	594.3	7.0	8	0.6	nnw.	21.0	85
10.53 p. m..	723.3	6.2	70	nw.	11.6	1,697	626.8	6.4	7	0.5	nnw.	17.1	0
10.58 p. m..	723.3	6.2	69	nw.	13.9	1,176	667.9	4.8	7	0.5	nnw.	15.3	0
11.00 p. m..	723.3	6.2	68	nw.	13.9	1,225	664.0	6.5	7	0.5	nnw.	13.4	0
11.06 p. m..	723.4	6.1	68	nw.	14.3	939	687.6	3.7	17	1.1	nnw.	17.4	0
11.20 p. m..	723.5	6.0	68	nw.	12.5	526	723.5	6.0	68	4.9	nw.	12.5	......
Sixth flight—													
11.49 p. m..	723.9	5.7	69	nw.	12.5	526	723.9	5.7	69	4.9	nw.	12.5	......
11.59 p. m..	724.0	5.2	74	nw.	10.3	934	688.6	2.9	71	4.2	nnw.	14.3	0
Oct. 16, 1912:													
12.06 a. m..	724.0	5.3	77	nw.	11.6	1,264	661.1	1.5	72	3.9	nnw.	14.8	0
12.27 a. m..	724.1	4.8	75	nw.	10.7	1,358	653.4	5.2	24	1.6	nnw.	8.9	170
1.06 a. m..	724.3	4.3	75	wnw.	9.8	1,637	631.6	2.7	11	0.6	nnw.	9.9	260
1.15 a. m..	724.3	4.1	76	wnw.	11.2	2,363	577.9	6.8	9	0.7	nnw.	10.2	640
1.24 a. m..	724.3	3.9	77	wnw.	9.8	3,399	509.1	2.8	8	0.5	nnw.	14.7	......
1.38 a. m..	724.4	3.5	80	wnw.	8.5	3,054	531.2	3.8	8	0.5	nnw.	12.9	640
1.46 a. m..	724.4	3.4	80	wnw.	8.9	2,192	590.2	6.7	8	0.6	nnw.	8.2	375
2.05 a. m..	724.4	2.9	82	wnw.	9.4	1,952	607.6	4.8	5	0.3	nnw.	10.2	185
2.19 a. m..	724.4	2.8	82	wnw.	10.7	1,345	654.6	3.9	......	....	nnw.	8.7	0
2.23 a. m..	724.4	2.8	82	wnw.	10.3	1,044	679.4	1.5	......	....	nnw.	12.3	0
2.35 a. m..	724.4	2.7	82	wnw.	9.8	526	724.4	2.7	82	4.8	wnw.	9.8	......
Seventh flight—													
3.02 a. m...	724.4	2.7	81	wnw.	13.4	526	724.4	2.7	81	4.7	wnw.	13.4	......
3.13 a. m...	724.5	3.1	80	wnw.	10.3	1,029	680.8	1.5	73	3.9	nnw.	13.3	20
4.25 a. m...	724.9	2.8	78	wnw.	11.6	1,346	654.8	1.4	20	1.1	nnw.	7.7	530
4.30 a. m...	724.9	2.6	79	wnw.	10.7	2,374	576.9	4.8	19	1.3	nnw.	13.3	955
4.37 a. m...	724.9	2.5	80	wnw.	8.0	3,208	520.8	2.7	18	1.0	nnw.	12.4	1,050
4.44 a. m...	725.0	2.4	81	wnw.	7.6	3,338	512.8	3.2	19	1.1	nnw.	13.9	1,010
4.53 a. m...	725.1	2.3	82	wnw.	6.3	3,234	519.7	2.7	19	1.1	nnw.	14.0	960
5.16 a. m...	725.2	2.2	80	wnw.	8.5	2,352	579.3	4.5	18	1.2	nnw.	11.8	440
5.33 a. m...	725.3	1.9	82	wnw.	9.8	1,566	638.0	3.1	16	1.0	nnw.	7.7	0
5.38 a. m...	725.3	1.9	83	wnw.	10.3	1,180	669.0	5.5	15	1.0	nnw.	7.7	0
5.50 a. m...	725.4	2.0	83	wnw.	11.2	913	691.4	2.4	18	1.0	nnw.	....	0
5.56 a. m...	725.4	2.0	83	wnw.	10.3	526	725.4	2.0	83	4.6	wnw.	10.3	......

Fifth flight: Five kites were used; lifting surface, 30.6 sq. m. Wire out, 5,500 m.; at maximum altitude, 5,200 m.

The sky was cloudless.

Sixth flight: Six kites were used; lifting surface, 37.8 sq. m. Wire out, 5,500 m.; at maximum altitude, 5,000 m.

The sky was cloudless.

October 16, 1912.—Seventh flight: Six kites were used; lifting surface, 39.8 sq. m.; Wire out, 5,400 m.; at maximum altitude, 4,500 m.

The sky was cloudless until 5.15 a. m., when Ci.-St. from the northwest appeared, increasing to 2/10.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Height	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
Oct. 16, 1912:													
Eighth flight—	*mm.*	*°C.*	*%*		*m. p. s.*	*m.*	*mm.*	*°C.*	*%*	*g.cu.m.*		*m. p. s.*	*Volts.*
6.19 a. m.	725.4	1.8	83	wnw.	9.8	526	725.4	1.8	83	4.5	wnw.	9.8	......
6.27 a. m.	725.4	1.9	83	wnw.	10.3	902	692.4	2.5	61	3.5	nnw.	6.1	0
8.19 a. m.	725.8	3.8	76	wnw.	9.4	1,063	679.3	5.3	10	0.7	n.	3.9	......
8.22 a. m.	725.8	3.8	76	wnw.	9.4	1,221	666.4	3.9	10	0.6	n.	6.5	......
8.27 a. m.	725.8	3.8	76	wnw.	8.9	1,656	631.8	5.4	9	0.6	n.	6.6	......
8.30 a. m.	725.8	3.9	75	wnw.	8.9	1,494	644.6	3.8	9	0.6	n.	6.6	......
8.37 a. m.	725.8	4.0	74	wnw.	8.5	909	692.4	6.3	8	0.6	n.	3.7	......
8.53 a. m.	725.9	4.3	73	wnw.	8.9	757	705.6	2.7	18	1.0	nw.	......	......
8.56 a. m.	725.9	4.4	73	nw.	8.9	526	725.9	4.4	73	4.7	nw.	8.9	......
Oct. 23, 1912:													
8.32 a. m.	710.2	13.8	85	wnw.	10.3	526	710.2	13.8	85	10.0	wnw.	10.3	......
8.42 a. m.	710.3	13.6	87	wnw.	12.5	971	673.6	11.5	83	8.5	wnw.	14.3	0
8.51 a. m.	710.3	13.6	87	wnw.	11.6	1,535	629.6	9.7	67	6.1	nw.	15.3	0
9.03 a. m.	710.4	13.9	85	wnw.	12.1	1,777	611.8	10.6	55	5.3	wnw.	11.5	0
9.27 a. m.	710.5	14.1	85	wnw.	8.9	1,847	606.8	8.1	64	5.3	wnw.	7.1	0
10.00 a. m.	710.6	14.4	84	wnw.	11.2	2,053	591.9	5.1	78	5.3	w.	8.7	0
10.13 a. m.	710.6	13.6	84	wnw.	17.9	2,223	579.4	4.1	81	5.2	w.	7.6	......
10.32 a. m.	710.6	13.0	78	w.	17.9	1,737	614.3	7.8	66	5.4	w.	5.6	0
10.45 a. m.	710.6	12.7	77	wnw.	17.0	1,400	639.8	9.7	67	6.1	wnw.	7.9	0
10.51 a. m.	710.6	12.6	77	wnw.	17.4	1,314	646.3	9.7	67	6.1	wnw.	11.2	0
10.58 a. m.	710.6	12.4	77	wnw.	15.2	1,133	660.5	7.9	87	7.1	nw.	17.2	0
11.07 a. m.	710.6	12.4	75	nw.	7.4	843	684.2	9.1	86	7.6	nw.	18.4	0
11.14 a. m.	710.6	12.8	76	nw.	17.4	526	710.6	12.8	76	8.4	nw.	17.4	....
Oct. 30, 1912:													
First flight—													
8.36 a. m.	716.4	16.3	52	w.	8.9	526	716.4	16.3	52	7.1	w.	8.9	......
8.44 a. m.	716.4	16.5	54	w.	7.6	933	682.9	14.0	61	7.3	w.	17.3	0
8.48 a. m.	716.4	16.8	53	w.	8.0	1,148	665.8	12.7	65	7.2	nw.	20.3	0
8.50 a. m.	716.4	16.9	53	w.	8.5	1,382	647.5	12.9	68	7.6	nw.	17.8	0
8.56 a. m.	716.4	16.9	53	w.	8.9	1,585	632.1	12.3	70	7.5	nw.	17.8	0
9.04 a. m.	716.4	16.9	53	w.	8.5	2,101	594.2	8.0	73	6.0	wnw.	20.2	350
9.07 a. m.	716.4	16.9	53	w.	8.0	2,454	569.5	8.5	66	5.6	wnw.	17.3	590
9.13 a. m.	716.4	16.8	56	w.	8.0	2,666	555.0	7.8	60	4.9	wnw.	21.4	590
9.15 a. m.	716.4	16.8	56	w.	8.0	2,702	552.5	7.8	59	4.8	wnw.	24.2	610
9.21 a. m.	716.4	17.0	57	w.	8.5	3,174	521.6	2.9	58	3.4	w.	22.2	820
9.24 a. m.	716.4	17.1	57	w.	9.4	3,397	507.5	3.1	47	2.8	w.	22.2	920
9.32 a. m.	716.5	17.1	57	w.	9.8	3,772	484.6	0.1	28	1.4	w.	20.4	1,040
9.34 a. m.	716.5	17.1	57	w.	9.8	526	716.5	17.1	57	8.2	w.	9.8	......

Eighth flight: Six kites were used; lifting surface, 39.8 sq. m. Wire out, 4,500 m.; at maximum altitude, 1,900 m.

Ci.-St.. from the northwest, decreased from 2/10 to few.

At 8 a. m., high pressure (775 mm.) was central over Ohio and low pressure (749 mm.) over Newfoundland.

October 23, 1912: Five kites were used; lifting surface, 31.5 sq. m. Wire out, 5,450 m., at maximum altitude.

Before 10 a. m. there were 9/10 St.-Cu. from the southwest. Then the sky was covered with two layers of St.-Cu., an upper one from the southwest and a lower one from the west. The head kite was in the lower layer of St.-Cu. from 10.02 to 10.16 a. m., altitude about 2,100 m. There was light rain from 8.32 to 8.57 a. m., from 9.53 to 10.16 a. m., and from 11.10 to 11.12 a. m.

High pressure (771 mm.) was central over Iowa and low pressure (754 mm.) was central over New York.

October 30, 1912.—First flight: Four kites were used; lifting surface, 25.2 sq. m. Wire out, 5,000 m., at maximum altitude.

The sky was covered with Ci.-St. and Ci.-Cu. from the west-southwest and with A.-Cu. from the southwest.

Low pressure (753 mm.) was central over the lower St. Lawrence Valley. High pressure (770 mm.) central over South Dakota extended to the South Atlantic coast.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Height	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
Oct. 30, 1912:													
Second flight—	*mm.*	*°C.*	*%*		*m. p. s.*	*m.*	*mm.*	*°C.*	*%*	*g.cu.m.*		*m. p. s.*	*Volts.*
10.34 a. m.	716.6	18.9	54	w.	7.6	526	716.6	18.9	54	8.7	w.	7.6	......
10.49 a. m.	716.6	18.7	54	w.	8.9	973	680.0	13.0	66	7.4	w.	14.3	0
11.03 a. m.	716.6	19.1	54	w.	8.5	1,192	662.5	11.0	76	7.5	w.	17.5	0
11.14 a. m.	716.6	18.9	54	w.	7.2	1,677	625.0	6.5	91	6.8	w.	17.4	0
11.24 a. m.	716.6	18.8	53	w.	8.5	2,165	588.8	4.4	88	5.7	w.	21.4	220
11.39 a. m.	716.5	18.7	54	w.	7.6	2,390	572.5	3.4	74	4.5	wnw.	19.8	330
11.56 a. m.	716.5	18.5	58	w.	10.7	2,404	571.6	3.1	80	4.8	w.	22.9	425
12.04 p. m.	716.5	18.5	58	w.	8.9	2,625	556.1	1.5	81	4.3	wnw.	21.9	510
12.15 p. m.	716.4	18.4	57	w.	10.3	3,052	527.5	3.0	39	2.3	w.	23.2	705
12.28 p. m.	716.3	19.2	59	w.	10.7	2,810	543.6	1.5	68	3.6	w.	22.4	590
12.40 p. m.	716.2	19.0	60	w.	7.6	2,575	559.7	2.3	71	4.0	wnw.	22.2	530
12.51 p. m.	716.2	19.2	58	w.	9.4	2,291	579.6	3.1	70	4.2	wnw.	22.9	460
1.09 p. m.	716.1	18.7	59	wnw.	8.9	1,623	628.7	8.2	69	5.7	w.	20.5	0
1.24 p. m.	716.1	19.7	55	wnw.	8.5	894	686.0	13.4	69	8.0	wnw.	12.4	0
1.32 p. m.	716.2	19.8	53	wnw.	10.3	526	716.2	19.8	53	9.0	wnw.	10.3	......
Third flight—													
2.03 p. m.	716.2	20.4	52	w.	7.2	526	716.2	20.4	52	9.1	w.	7.2	......
2.05 p. m.	716.2	20.4	51	w.	8.5	614	709.0	19.6	51	8.5	wnw.	7.3	0
2.21 p. m.	716.2	20.4	43	w.	9.8	923	683.8	15.1	52	6.7	wnw.	10.2	0
2.30 p. m.	716.2	20.4	45	w.	10.7	1,450	642.4	9.9	57	5.3	wnw.	14.9	0
2.44 p. m.	716.2	20.1	42	wnw.	10.7	1,557	634.1	9.0	64	5.6	w.	19.1	30
2.47 p. m.	716.2	20.1	42	wnw.	8.9	1,946	604.8	4.6	62	4.1	w.	19.1	150
2.50 p. m.	716.2	20.2	43	wnw.	8.9	2,221	585.0	5.2	47	3.2	w.	26.3	230
3.01 p. m.	716.2	20.4	43	wnw.	10.7	2,712	550.6	1.4	46	2.4	w.	25.7	430
3.03 p. m.	716.2	20.4	43	wnw.	10.7	2,871	539.9	1.6	57	3.1	w.	25.7	540
3.07 p. m.	716.2	20.3	41	wnw.	10.3	3,035	529.0	0.6	59	3.0	w.	24.7	630
3.10 p. m.	716.2	20.3	41	wnw.	10.3	3,281	513.0	0.8	42	2.1	w.	22.3	755
3.15 p. m.	716.3	20.4	42	wnw.	10.3	3,330	509.5	−0.8	37	1.7	wnw.	22.3	755
3.25 p. m.	716.3	20.2	42	wnw.	9.4	3,075	525.5	−0.7	48	2.2	wnw.	22.6	510
3.40 p. m.	716.4	20.0	43	wnw.	9.4	2,755	547.0	0.2	64	3.1	w.	23.0	200
3.53 p. m.	716.5	19.8	43	wnw.	4.9	2,370	574.0	0.4	49	2.4	w.	19.8	0
3.59 p. m.	716.5	19.8	43	wnw.	5.8	2,116	592.2	1.6	61	3.3	w.	11.9	0
4.07 p. m.	716.5	19.6	43	nw.	5.4	1,292	654.7	9.6	73	6.6	w.	13.0	0
4.14 p. m.	716.5	19.3	43	wnw.	5.8	878	687.7	14.7	56	7.0	wnw.	....	0
4.16 p. m.	716.5	19.2	43	nw.	5.8	526	716.5	19.2	43	7.0	nw.	5.8	......
Fourth flight—													
4.44 p. m.	716.6	18.3	44	nw.	5.4	526	716.6	18.3	44	6.8	nw.	5.4	......
4.57 p. m.	716.6	17.7	43	nw.	7.6	909	685.3	15.8	43	5.7	nw.	9.9	0
5.08 p. m.	716.7	17.5	44	nw.	7.6	1,009	677.4	14.9	43	5.4	wnw.	10.8	0
5.22 p. m.	716.7	17.0	45	wnw.	7.6	1,252	658.1	12.3	49	5.3	wnw.	10.2	0
5.45 p. m.	716.9	16.4	45	wnw.	5.8	1,447	643.0	9.5	54	4.9	w.	9.6	0
6.25 p. m.	717.2	15.7	45	wnw.	11.6	1,714	622.7	7.2	39	3.0	wnw.	15.5	0
6.45 p. m.	717.3	15.5	43	nw.	10.7	1,825	614.5	6.2	32	2.3	wnw.	20.5	140
6.46 p. m.	717.3	15.5	43	nw.	11.2	2,055	597.4	6.5	28	2.1	wnw.	20.5	210
6.50 p. m.	717.3	15.4	43	nw.	10.3	2,313	579.1	6.5	21	1.6	wnw.	17.4	260
7.04 p. m.	717.4	15.0	43	nw.	8.9	2,809	544.9	3.2	10	0.6	wnw.	19.8	380
7.18 p. m.	717.5	14.9	43	nw.	8.9	3,215	518.0	1.3	9	0.5	wnw.	18.6	......
7.36 p. m.	717.5	14.5	43	nw.	8.9	2,852	541.4	2.8	20	1.2	wnw.	18.3	340
7.44 p. m.	717.5	14.4	43	nw.	9.8	2,562	561.0	4.5	20	1.3	wnw.	16.7	170
7.46 p. m.	717.6	14.3	43	nw.	9.8	2,331	577.2	4.3	17	1.1	wnw.	16.1	170
7.58 p. m.	717.6	14.1	44	nw.	10.7	2,175	588.2	5.3	15	1.0	wnw.	18.1	140
8.00 p. m.	717.6	14.1	44	nw.	9.8	1,819	614.5	5.1	19	1.3	wnw.	16.9	70
8.10 p. m.	717.6	13.9	45	nw.	9.4	1,468	641.2	7.2	35	2.7	wnw.	12.4	0
8.25 p. m.	717.7	13.9	45	nw.	9.4	1,002	678.3	11.2	40	4.0	wnw.	16.1	0
8.33 p. m.	717.7	14.2	46	nw.	8.9	526	717.7	14.2	46	5.6	nw.	8.9	......

Second flight.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 5,000 m., at maximum altitude.

Ci.-St., Ci.-Cu., and A.-Cu. from the west-southwest, and A.-St., Cu., and St.-Cu. from the west, covered 10/10 to 6/10 of the sky.

Third flight.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 5,000 m., at maximum altitude.

There were 4/10 to 1/10 Ci.-St. from the southwest and a few Cu. from the west.

Fourth flight.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 5,000 m., at maximum altitude.

There were a few Ci.-St. from the west-southwest, and a few St.-Cu. from the west before 7.00 p. m.; thereafter the sky was cloudless.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Height	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
Oct. 30, 1912:													
Fifth flight—	*mm.*	*°C.*	*%*		*m. p. s.*	*m.*	*mm.*	*°C.*	*%*	*g. cu. m.*		*m. p. s.*	*Volts.*
9.02 p. m..	717.8	13.6	45	nw.	8.9	526	717.8	13.6	45	5.3	nw.	8.9	......
9.12 p. m..	717.9	13.4	43	nw.	9.4	966	681.4	11.3	46	4.7	nw.	12.1	0
9.23 p. m..	718.0	13.8	37	nw.	10.3	1,364	649.7	9.4	45	4.0	wnw.	14.3	0
9.36 p. m..	718.2	12.8	40	nw.	8.9	1,999	601.9	8.9	23	2.0	wnw.	16.7	170
9.43 p. m..	718.2	12.4	43	nw.	8.9	2,370	575.6	6.3	26	1.9	wnw.	18.0	480
9.44 p. m..	718.2	12.4	43	nw.	8.0	2,475	568.3	6.4	26	1.9	wnw.	18.0	565
9.49 p. m..	718.3	12.5	38	nw.	9.4	2,845	543.1	3.8	42	2.6	wnw.	17.4	565
10.00 p. m..	718.4	12.4	39	nw.	7.6	3,173	521.7	1.4	62	3.3	wnw.	17.4	890
10.03 p. m..	718.4	12.2	40	nw.	8.5	3,362	509.5	1.6	42	2.3	wnw.	17.4	890
10.09 p. m..	718.3	12.0	41	nw.	9.4	3,446	504.1	0.6	46	2.3	wnw.	16.2	......
10.21 p. m..	718.3	11.4	44	nw.	10.3	3,029	530.6	3.5	45	2.8	wnw.	14.9	710
10.25 p. m..	718.2	11.3	44	nw.	10.3	2,756	548.6	3.5	49	3.0	wnw.	17.4	650
10.34 p. m..	718.2	11.2	43	nw.	9.8	2,731	550.3	4.9	54	3.6	wnw.	16.1	650
10.37 p. m..	718.2	11.2	43	nw.	8.5	2,545	563.0	4.8	58	3.9	wnw.	14.8	570
10.49 p. m..	718.1	11.0	44	nw.	7.2	2,106	593.8	7.6	40	3.2	wnw.	16.1	425
10.56 p. m..	718.0	10.7	46	nw.	7.6	1,711	622.8	8.0	30	2.5	wnw.	15.7	350
11.04 p. m..	718.0	10.4	47	nw.	6.7	1,371	648.8	9.0	23	2.0	wnw.	14.9	330
11.15 p. m..	718.0	9.7	52	nw.	8.9	890	687.4	10.0	42	3.9	wnw.	13.6	0
11.25 p. m..	718.1	9.3	53	nnw.	10.7	674	705.5	10.9	49	4.8	nw.	12.6	0
11.28 p. m..	718.1	9.2	55	nnw.	11.2	526	718.1	9.2	55	4.9	nnw.	11.2	......
Oct. 31, 1912:													
Sixth flight—													
12.01 a. m..	718.2	8.6	59	nnw.	8.0	526	718.2	8.6	59	5.0	nnw.	8.0	......
12.05 a. m..	718.2	8.7	62	nnw.	8.0	897	686.8	10.4	56	5.4	nw.	12.4	0
12.11 a. m..	718.2	8.6	61	nnw.	7.2	983	679.8	10.1	57	5.4	nw.	14.3	0
12.23 a. m..	718.2	8.2	65	nnw.	11.6	1,563	634.1	10.0	27	2.5	wnw.	16.1	380
12.38 a. m..	718.2	7.8	68	n.	7.6	2,131	592.2	8.6	27	2.3	wnw.	16.1	780
12.55 a. m..	718.2	7.8	68	nnw.	9.8	2,756	548.7	3.5	61	3.7	wnw.	15.5	1,140
1.09 a. m..	718.2	7.6	73	nnw.	8.0	3,191	520.1	0.3	73	3.6	w.	12.4	1,180
1.18 a. m..	718.2	7.6	71	nnw.	8.5	3,408	506.0	−0.2	68	3.2	w.	16.7	1,390
1.22 a. m..	718.2	7.5	71	nnw.	8.9	3,490	500.9	−0.4	67	3.1	w.	15.4	......
1.36 a. m..	718.3	7.1	72	nnw.	8.0	3,026	530.9	2.1	45	2.5	w.	16.1	1,140
1.41 a. m..	718.3	6.9	72	nnw.	8.0	2,838	543.4	2.5	56	3.2	w.	16.7	1,205
2.01 a. m..	718.3	6.7	70	nnw.	8.0	2,109	594.1	7.8	64	5.2	wnw.	17.4	780
2.21 a. m..	718.3	6.2	76	nnw.	8.9	1,456	642.4	11.6	31	3.2	wnw.	14.9	515
2.37 a. m..	718.3	5.8	79	n.	8.9	958	681.8	10.5	49	4.7	wnw.	12.4	170
2.40 a. m..	718.3	5.8	79	n.	8.9	862	689.7	10.6	48	4.7	nw.	12.5	140
2.46 a. m..	718.3	5.8	79	n.	9.8	526	718.3	5.8	79	5.6	n.	9.8	......
Seventh flight–													
3.23 a. m..	718.4	5.6	79	nnw.	11.6	526	718.4	5.6	79	5.6	nnw.	11.6	......
3.27 a. m..	718.4	5.7	79	nnw.	10.3	836	691.6	10.7	57	5.6	nw.	11.9	120
3.35 a. m..	718.4	5.6	79	nnw.	9.8	961	681.7	10.8	61	6.0	nw.	9.3	170
3.50 a. m..	718.5	5.4	81	nnw.	8.9	1,444	643.6	12.0	25	2.6	wnw.	11.7	490
4.02 a. m..	718.5	5.2	80	nnw.	8.9	2,183	588.9	7.6	47	3.8	wnw.	13.0	810
4.19 a. m..	718.6	5.4	80	nnw.	7.2	2,703	552.8	2.7	80	4.6	w.	16.5	1,170
4.25 a. m..	718.6	5.3	80	nnw.	6.3	2,757	549.2	2.3	87	4.9	w.	18.6	1,235
4.32 a. m..	718.7	5.2	80	nnw.	6.3	2,945	536.7	1.7	78	4.2	w.	16.7	1,470
4.47 a. m..	718.7	5.0	82	nnw.	6.3	3,357	509.2	−0.2	55	2.6	w.	16.5	......
5.05 a. m..	718.8	4.9	83	n.	4.9	2,746	549.2	1.7	80	4.3	w.	17.4	1,140
5.11 a. m..	718.9	4.9	83	n.	4.0	2,667	554.5	2.3	88	5.0	w.	16.7	1,090
5.25 a. m..	719.0	4.9	83	n.	4.0	2,153	590.8	6.5	76	5.7	w.	13.0	755
5.46 a. m..	719.1	5.0	82	nne.	3.6	1,504	639.0	10.9	31	3.1	wnw.	12.1	490
6.05 a. m..	719.2	5.0	83	ne.	4.0	1,181	664.3	9.6	56	5.1	nnw.	6.4	......
6.05 a. m..	719.3	5.1	80	ne.	4.0	526	719.3	5.1	80	5.4	ne.	4.0	......

Fifth flight.—Five kites were used; lifting surface, 31.5 sq. m. Wire out, 5,000 m.; at maximum altitude, 4,650 m.

Before 10.00 p. m. there were few to 1/10 St.-Cu. from the west-northwest; thereafter there were 1/10 to 4/10 A.-Cu. from the west-southwest.

October 31, 1912.—Sixth flight: Five kites were used; lifting surface, 33.5 sq. m. Wire out, 5,000 m.; at maximum altitude, 4,850 m.

There were 4/10 to 7/10 A.-Cu. from the west-southwest before 1 a. m.; thereafter there were 9/10 to 5/10 Ci., Ci.-St., A.-Cu., and A.-St. from the west. There was a lunar halo at 2.21 a. m.

Seventh flight: Five kites were used; lifting surface, 33.5 sq. m. Wire out, 5,000 m.; at maximum altitude, 4,500 m.

There were 6/10 to few Ci.-St. from the west.

At 8 a. m. high pressure (768 mm.) was central over Maryland and low pressure (754 mm.) was central over Texas.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Height	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
Nov. 6 1912:	*mm.*	*°C.*	%		*m. p. s.*	*m.*	*mm.*	*°C.*	%	*g.cu.m.*		*m. p. s.*	*Volts.*
8.40 a. m.	721.1	12.7	63	ssw.	8.5	526	721.1	12.7	63	7.0	ssw.	8.5	......
8.48 a. m.	721.1	13.0	61	ssw.	9.8	1,050	677.5	11.7	73	7.6	ssw.	19.7	0
9.04 a. m.	721.1	13.6	62	ssw.	9.8	1,385	650.8	9.3	75	6.7	ssw.	14.9	0
9.15 a. m.	721.0	13.4	65	ssw.	8.5	1,650	630.3	7.7	80	6.4	ssw.	14.3	0
9.49 a. m.	720.9	13.7	66	ssw.	8.0	1,987	604.8	6.0	77	5.6	sw.	9.9	270
10.01 a. m.	720.9	13.9	66	ssw.	9.8	2,493	568.6	2.1	82	4.6	sw.	16.1	640
10.39 a. m.	720.7	13.7	71	ssw.	9.4	3,112	525.5	−3.5	93	3.4	sw.	....	860
10.57 a. m.	720.6	13.9	72	s.	7.6	2,671	555.0	−0.4	97	4.5	sw.	....	630
11.07 a. m.	720.5	13.9	75	s.	10.7	2,413	573.1	1.0	95	4.9	sw.	....	470
11.20 a. m.	720.3	13.6	78	ssw.	8.9	1,925	608.4	3.8	94	5.9	ssw.	....	60
11.27 a. m.	720.2	13.6	78	ssw.	8.5	1,612	632.1	5.9	89	6.4	ssw.	....	0
11.44 a. m.	720.0	14.1	82	s.	10.3	977	682.4	9.7	90	8.2	ssw.	....	0
11.54 a. m.	719.9	14.7	81	s.	10.7	526	719.9	14.7	81	10.1	s.	10.7	......
Nov. 7, 1912:													
4.00 p. m.	705.0	13.2	100	wnw.	12.1	526	705.0	13.2	100	11.4	wnw.	12.1	......
4.09 p. m.	705.0	13.2	100	wnw.	14.3	997	666.4	10.0	87	8.1	nnw.	19.8	0
4.16 p. m.	705.1	13.2	100	wnw.	13.4	1,294	643.2	9.5	85	7.7	nw.	19.2	0
4.25 p. m.	705.1	13.2	100	wnw.	12.1	1,370	637.4	9.9	78	7.2	nw.	15.2	0
4.39 p. m.	705.2	13.2	100	wnw.	12.1	1,530	625.3	9.4	81	7.3	nw.	9.7	0
4.47 p. m.	705.2	13.2	100	wnw.	11.2	1,679	614.1	7.5	86	6.8	nw.	6.8	0
4.49 p. m.	705.2	13.2	100	wnw.	11.2	1,850	601.3	7.1	90	7.0	nw.	6.2	......
4.57 p. m.	705.3	13.2	100	wnw.	13.0	1,577	621.5	8.4	80	6.7	nw.	9.3	......
5.00 p. m.	705.3	13.2	100	wnw.	13.9	1,207	649.9	7.4	91	7.2	nw.	19.3	......
5.09 p. m.	705.3	13.2	100	wnw.	15.2	1,073	660.5	8.4	98	8.3	nnw.	14.9	......
5.21 p. m.	705.4	13.2	100	wnw.	14.3	526	705.4	13.2	100	11.4	wnw.	14.3	......
Nov. 11, 1912:													
9.07 a. m.	718.1	15.1	42	w.	12.1	526	718.1	15.1	42	5.4	w.	12.1	......
9.15 a. m.	718.2	15.3	42	w.	11.6	874	689.3	14.3	43	5.2	wsw.	14.3	0
9.25 a. m.	718.3	15.7	43	w.	11.2	1,313	654.4	12.7	43	4.7	w.	13.6	260
9.30 a. m.	718.3	16.2	44	w.	8.9	1,535	637.5	12.1	43	4.6	w.	14.6	475
9.31 a. m.	718.3	16.3	44	w.	8.9	1,634	630.1	12.1	41	4.4	w.	14.6	565
9.36 a. m.	718.3	16.3	42	w.	9.4	1,929	608.2	11.4	39	4.0	w.	12.1	540
9.50 a. m.	718.4	16.6	43	w.	8.5	2,389	575.6	7.7	39	3.1	w.	12.1	730
10.06 a. m.	718.5	16.5	44	w.	8.5	2,575	563.0	5.9	43	3.1	w.	7.4	730
10.45 a. m.	718.2	17.5	42	w.	8.0	2,887	541.5	2.7	49	2.8	wnw.	14.9	1,135
10.59 a. m.	718.1	17.6	40	w.	7.2	3,443	505.0	−2.2	54	2.2	wnw.	19.2	1,105
11.03 a. m.	718.1	17.9	41	w.	6.7	3,341	511.1	−1.7	55	2.3	wnw.	20.2	1,060
11.16 a. m.	718.0	17.9	42	w.	7.6	2,483	568.3	4.9	58	3.9	wnw.	8.1	890
11.31 a. m.	717.8	18.1	42	wsw.	8.5	2,400	573.9	6.2	52	3.8	wnw.	9.9	730
11.45 a. m.	717.7	18.5	43	wsw.	7.2	1,993	602.8	9.8	53	4.9	w.	13.6	515
11.49 a. m.	717.7	18.3	42	w.	7.2	1,697	624.7	11.0	49	4.9	wsw.	14.8	310
11.52 a. m.	717.7	18.2	42	w.	6.3	1,502	639.4	10.1	50	4.7	wsw.	17.6	170
12.00 m.	717.6	18.8	42	w.	8.0	1,236	660.1	10.6	53	5.1	sw.	9.5	0
12.09 p. m.	717.5	18.5	43	s.	7.2	526	717.5	18.5	43	6.7	s.	7.2	......

November 6, 1912.—Four kites were used; lifting surface, 25.2 sq. m. Wire out, 5,200 m.; at maximum altitude, 4,600 m.

There were 1/10 Ci.-St. and 8/10 A.-Cu. until 10 a. m., and 10/10 St.-Cu. thereafter; all from the southwest. Rain fell 11.10 to 11.15 a. m. The head kite entered St.-Cu. at 10.06 a. m., altitude 2,900 m., and emerged at 11 a. m., altitude 2,550 m.

High pressure (772 mm.) was central over the Atlantic, and low pressure (756 mm.) over Illinois.

November 7, 1912.—Three kites were used; lifting surface, 18.9 sq. m. Wire out, 3,500 m.; at maximum altitude, 3,200 m.

There was dense fog. Rain fell after 4.08 p. m.

High pressure (767 mm.) was central over the Atlantic, low pressure (753 mm.) over North Carolina.

November 11, 1912.—Seven kites were used; lifting surface, 44.6 sq. m. Wire out, 6,000 m.; at maximum altitude, 5,100 m.

Ci.-St. from northwest increased from 2/10 to 8/10.

High pressure (771 mm.) was central over Georgia and low pressure (751 mm.) was central over Minnesota.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind. Dir.	Wind. Vel.	Height	Pressure.	Temperature.	Humidity. Rel.	Humidity. Abs.	Wind. Dir.	Wind. Vel.	P. D. kite and earth.
Nov. 12, 1912:													
First flight—	*mm.*	*°C.*	*%*		*m. p. s.*	*m.*	*mm.*	*°C.*	*%*	*g.cu.m.*		*m. p. s.*	*Volts.*
8.39 a. m..	718.0	16.0	37	wnw.	11.2	526	718.0	16.0	37	5.0	wnw.	11.2	......
8.43 a. m..	718.0	16.0	38	wnw.	10.7	908	686.5	15.2	35	4.5	wnw.	15.5	0
8.57 a. m..	718.0	16.4	38	wnw.	13.4	1,398	647.8	11.9	39	4.1	nw.	19.2	460
9.06 a. m..	718.0	16.5	41	wnw.	14.3	1,618	631.1	10.4	38	3.6	nw.	18.5	760
9.08 a. m..	718.0	16.5	41	wnw.	13.9	1,789	618.2	9.7	37	3.4	nw.	17.9	700
9.13 a. m..	718.0	16.4	39	wnw.	13.4	2,215	587.4	8.4	37	3.1	nw.	21.6	1,000
9.21 a. m..	718.0	16.5	41	wnw.	13.1	2,424	572.8	8.4	34	2.9	wnw.	22.6	870
9.30 a. m..	718.0	17.0	36	wnw.	14.3	3,144	524.3	2.6	27	1.6	wnw.	23.3	1,350
9.35 a. m..	717.9	17.0	36	wnw.	13.4	2,949	536.8	2.8	28	1.6	wnw.	21.7	1,275
9.49 a. m..	717.9	16.8	39	wnw.	13.4	2,550	563.8	6.6	29	2.2	wnw.	23.6	1,055
9.58 a. m..	717.9	17.1	39	wnw.	12.5	2,288	581.9	8.5	28	2.4	wnw.	21.6	920
10.05 a. m..	717.9	17.4	38	wnw.	8.9	2,108	594.7	8.5	31	2.6	wnw.	21.1	835
10.11 a. m..	717.9	17.5	38	wnw.	10.7	1,960	605.4	10.0	31	2.9	nw.	17.9	860
10.14 a. m..	717.9	17.6	38	wnw.	9.4	1,784	618.2	9.6	33	3.0	nw.	17.9	670
10.26 a. m..	717.9	17.8	36	wnw.	9.8	1,346	651.6	10.7	36	3.5	nw.	19.8	425
10.40 a. m..	717.8	18.0	35	w.	10.7	907	686.5	13.9	36	4.3	w.	13.6	0
10.46 a. m..	717.8	18.4	34	w.	10.7	526	717.8	18.4	34	5.3	w.	10.7	......
Second flight—													
11.21 a. m..	717.7	17.8	38	w.	9.8	526	717.7	17.8	38	5.7	w.	9.8	......
11.32 a. m..	717.6	18.4	32	w.	12.1	892	687.5	14.6	36	4.5	w.	13.0	0
11.39 a. m..	717.5	18.6	31	w.	11.6	1,391	647.9	11.1	37	3.7	w.	20.5	370
11.54 a. m..	717.4	18.5	42	w.	12.5	1,968	604.6	11.3	34	3.4	w.	20.8	790
12.02 p. m..	717.4	18.6	42	w.	10.7	2,353	577.4	8.8	30	2.6	w.	20.1	1,140
12.45 p. m..	716.9	20.3	38	w.	12.1	2,983	534.2	1.8	30	1.6	w.	19.8	1,350
1.06 p. m..	716.7	20.0	37	w.	11.6	2,664	555.7	3.9	32	2.0	w.	21.7	1,240
1.25 p. m..	716.6	20.0	34	w.	13.4	2,013	601.0	10.2	28	2.6	w.	19.8	920
1.44 p. m..	716.5	20.0	34	w.	10.7	1,469	641.3	13.9	26	3.1	w.	19.8	330
1.52 p. m..	716.4	20.1	35	w.	11.2	1,245	658.3	12.8	34	3.8	wnw.	15.3	180
2.01 p. m..	716.4	20.1	35	w.	10.3	841	690.5	15.1	40	5.1	w.	9.9	0
2.07 p. m..	716.4	20.2	39	w.	9.8	526	716.4	20.2	39	6.8	w.	9.8	......
Nov. 14, 1912:													
First flight—													
8.32 a. m..	710.3	4.6	80	nw.	10.7	526	710.3	4.6	80	5.3	nw.	10.7	......
8.40 a. m..	710.3	4.4	82	nw.	10.3	889	679.2	2.2	77	4.3	wnw.	13.0	0
8.58 a. m..	710.3	4.3	83	nw.	10.3	1,185	654.7	2.2	67	3.8	wnw.	10.5	140
9.05 a. m..	710.3	4.4	83	nw.	11.6	1,003	669.8	4.1	63	4.0	w.	9.8	0
9.11 a. m..	710.3	4.8	80	nw.	10.3	1,317	644.2	1.8	63	3.4	w.	7.1	330
9.18 a. m..	710.3	5.4	78	nw.	12.1	1,956	594.8	− 2.3	72	2.9	wsw.	10.5	540
9.35 a. m..	710.4	5.8	79	nw.	11.2	2,546	552.1	− 5.2	51	1.6	wsw.	14.9	1,280
10.83 a. m..	710.3	7.4	68	nw.	13.9	3,075	516.0	− 9.6	33	0.7	wsw.	24.5	......
10.42 a. m..	710.3	7.4	64	wnw.	8.9	3,495	488.2	−10.1	34	0.7	sw.	26.0	......
10.48 ȧ. m..	710.2	7.5	66	wnw.	12.5	3,347	497.4	−10.9	34	0.7	sw.	19.7	......
11.02 a. m..	710.2	7.4	67	nw.	11.6	2,748	537.1	− 7.6	29	0.8	sw.	12.5	1,330
11.17 a. m..	710.1	7.6	68	wnw.	13.4	1,964	593.7	− 4.4	38	1.3	wsw.	10.9	1,140
11.27 a. m..	710.1	8.0	63	nw.	14.8	1,378	639.4	− 0.6	45	2.1	w.	11.8	660
11.32 a. m..	710.1	8.1	62	nw.	11.2	1,362	640.6	− 1.5	55	2.4	w.	11.1	660
11.43 a. m..	710.1	8.3	60	wnw.	13.0	1,017	668.7	1.9	67	3.7	wnw.	10.2	40
11.52 a. m..	710.0	7.8	65	wnw.	10.3	526	710.0	7.8	65	5.3	wnw.	10.3	......

November 12, 1912.—First flight: Four kites were used; lifting surface, 25.2 sq. m. Wire out, 5,000 m.; at maximum altitude, 4,900 m.

There were 9/10 to 5/10 Ci. and 1/10 to few Ci. Cu. from the west.

High pressure (769 mm.) was central over Georgia. Low pressure was central over the lower St. Lawrence Valley (756 mm.) and over Missouri (752 mm.).

Second flight: Five kites were used; lifting surface, 31.5 sq. m. Wire out, 5,700 m., at maximum altitude.

There were 8/10 to 10/10 Ci. from the west, and before 1 p. m. there were a few Ci.-Cu. also from west.

November 14, 1912.—First flight: Six kites were used; lifting surface, 37.8 sq. m. Wire out, 5,600 m; at maximum altitude, 4,500 m.

St.-Cu., from the southwest, altitude 2,000 m., decreased from 7/10 to 1/10. 1/10 A.-Cu. was observed about 11.15 a. m.

At 8 a. m. low pressure (754 mm.) was central over southern Ontario; high pressure (768 mm.) was central over Minnesota.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Height	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
Nov. 14, 1912:													
Second flight—	*mm.*	*°C.*	*%*		*m. p. s.*	*m.*	*mm.*	*°C.*	*%*	*g. cu. m.*		*m. p. s.*	*Volts.*
12.22 p. m.	710.0	8.4	62	w.	9.4	526	710.0	8.4	62	5.2	w.	9.4	......
12.38 p. m.	709.9	8.5	58	w.	10.3	758	690.1	4.0	61	3.9	wnw.	9.0	0
12.58 p. m.	709.9	9.0	59	w.	8.5	1,104	661.2	1.0	66	3.4	w.	8.4	0
1.30 p. m.	709.8	9.0	53	wnw.	9.8	1,275	647.2	− 1.1	69	3.1	w.	10.5	0
1.50 p. m.	709.8	9.0	53	w.	10.7	1,979	592.1	− 4.8	59	1.9	wsw.	11.9	1,070
2.12 p. m.	709.9	9.3	52	w.	9.8	2,552	550.5	− 8.3	55	1.4	wsw.	13.6	1,510
2.19 p. m.	709.9	8.7	52	w.	14.3	3,029	517.6	−11.2	49	1.0	wsw.	19.2	1,710
2.25 p. m.	710.0	8.6	52	w.	13.0	3,468	488.7	−11.2	43	0.8	sw.	22.9	1,735
2.32 p. m.	710.0	9.1	49	w.	11.2	3,752	470.7	−12.8	41	0.7	sw.	24.2	2,340
2.46 p. m.	710.1	9.0	50	w.	8.9	3,460	488.7	−11.3	41	0.8	sw.	23.0	1,930
2.48 p. m.	710.1	9.0	50	w.	8.9	3,318	497.9	−11.8	40	0.7	sw.	23.0	1,830
2.55 p. m.	710.2	8.9	50	w.	9.8	3,100	512.3	−10.6	39	0.8	sw.	23.0	1,510
3.03 p. m.	710.2	8.7	49	w.	10.3	2,621	545.1	−10.8	37	0.7	wsw.	13.7	920
3.15 p. m.	710.3	8.1	54	wnw.	8.0	1,939	572.0	− 9.1	65	1.5	w.	13.2	825
3.23 p. m.	710.4	8.0	54	w.	8.9	1,939	595.5	− 7.7	76	2.0	w.	16.5	735
3.33 p. m.	710.4	8.0	49	wnw.	8.0	1,312	644.8	− 0.9	72	3.2	w.	9.4	280
3.41 p. m.	710.5	8.2	47	wnw.	7.2	834	684.4	4.0	65	4.1	w.	7.8	0
3.48 p. m.	710.5	8.1	50	w.	7.6	526	710.5	8.1	50	4.1	w.	7.6	......
Third flight—													
4.25 p. m.	710.8	6.5	64	nw.	9.4	526	710.8	6.5	64	4.8	nw.	9.4	......
4.48 p. m.	711.0	5.4	73	wnw.	7.2	917	677.6	2.7	71	4.1	wnw.	10.8	0
4.55 p. m.	711.1	5.2	74	wnw.	8.9	1,201	654.2	0.5	71	3.6	wnw.	9.0	30
5.15 p. m.	711.2	5.0	75	wnw.	6.7	1,915	597.9	− 6.0	83	2.5	w.	13.0	330
5.39 p. m.	711.4	5.0	71	nw.	11.6	2,466	557.4	− 9.7	88	1.9	wsw.	11.2	960
6.01 p. m.	711.5	5.0	66	nw.	8.9	2,676	542.4	−11.3	87	1.7	wsw.	11.6	1,545
6.03 p. m.	711.5	4.9	65	nw.	11.6	2,969	522.3	− 8.5	77	1.9	wsw.	16.6	1,205
6.07 p. m.	711.6	4.9	64	nw.	8.5	3,263	502.6	− 8.7	73	1.7	wsw.	17.2	......
6.26 p. m.	711.8	4.4	61	nw.	13.4	2,801	533.0	− 8.4	69	1.7	wsw.	14.9	1,240
6.33 p. m.	711.9	4.3	61	nw.	13.0	2,579	548.8	−10.8	70	1.4	wsw.	12.6	1,095
7.01 p. m.	712.3	4.2	65	wnw.	12.1	2,035	588.9	− 8.0	96	2.4	wsw.	15.0	730
7.19 p. m.	712.3	3.9	63	wnw.	8.5	1,441	635.4	− 4.9	84	2.7	w.	15.0	260
7.35 p. m.	712.3	3.8	63	wnw.	9.8	915	678.8	0.1	70	3.4	w.	14.3	0
7.42 p. m.	712.3	3.8	63	wnw.	9.8	526	712.3	3.8	63	3.9	wnw.	9.8	......
Fourth flight—													
8.07 p. m.	712.3	3.8	63	wnw.	17.9	526	712.3	3.8	63	3.9	wnw.	17.9	......
8.13 p. m.	712.3	3.8	60	wnw.	17.9	943	676.4	0.1	65	3.2	w.	19.2	0
8.26 p. m.	712.3	3.8	58	wnw.	14.8	1,587	623.7	− 6.0	81	2.4	wnw.	18.6	170
8.28 p. m.	712.3	3.8	58	wnw.	13.0	1,872	601.4	− 7.7	84	2.2	wnw.	18.3	470
8.36 p. m.	712.3	3.9	57	wnw.	13.0	2,049	588.0	− 3.8	61	2.2	nw.	8.7	810
8.53 p. m.	712.3	3.9	60	wnw.	12.1	2,243	573.7	− 6.4	66	1.9	wnw.	7.4	1,150
9.12 p. m.	712.3	3.7	61	wnw.	16.5	2,428	559.8	− 8.4	69	1.7	wnw.	10.2	1,315
9.28 p. m.	712.3	3.5	61	wnw.	14.8	2,085	584.6	− 8.0	76	1.9	wnw.	8.4	1,110
9.40 p. m.	712.2	3.4	63	wnw.	15.6	1,847	602.6	− 6.0	80	2.4	wnw.	8.2	770
10.03 p. m.	712.2	3.4	65	wnw.	13.9	1,800	606.2	− 9.0	97	2.3	wnw.	17.6	720
10.16 p. m.	712.2	3.2	65	wnw.	17.0	1,568	624.8	− 7.3	96	2.6	wnw.	17.2	630
10.36 p. m.	712.2	3.2	66	wnw.	14.8	912	678.8	− 1.1	80	3.5	wnw.	18.6	0
10.50 p. m.	712.2	3.0	69	wnw.	14.3	526	712.2	3.0	69	4.1	wnw.	14.3	......

Second flight: Five kites were used; lifting surface, 31.5 sq. m. Wire out, 5,000 m., at maximum altitude.

St.-Cu., from the west-southwest, increased from 2/10 to 7/10.

Third flight: Five kites were used; lifting surface, 31.5 sq. m. Wire out, 5,000 m.; at maximum altitude, 4,400 m.

St.-Cu., from the west-southwest, varied from 8/10 to 4/10.

Fourth flight: Five kites were used; lifting surface, 31.5 sq. m. Wire out, 5,000 m., at maximum altitude.

St.-Cu., changing in direction from west-southwest to northwest, increased from 3/10 to 10/10.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Height	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
Nov. 14, 1912:													
Fifth flight—	*mm.*	*°C.*	*%*		*m. p. s.*	*m.*	*mm.*	*°C.*	*%*	*g.cu.m.*		*m. p. s.*	*Volts.*
11.21 p. m.	712.2	2.8	66	nw.	13.4	526	712.2	2.8	66	3.9	nw.	13.4	......
11.30 p. m.	712.2	2.6	69	nw.	13.9	970	673.9	− 1.0	69	3.1	w.	17.8	0
11.40 p. m.	712.1	2.6	69	nw.	15.6	1,378	639.9	− 5.0	82	2.7	wnw.	16.1	780
Nov. 15, 1912:													
12.06 a. m.	712.1	2.6	69	nw.	16.5	2,045	587.7	− 8.2	96	2.4	nw.	....	1,470
12.07 a. m.	712.1	2.6	69	nw.	16.7	2,121	582.1	− 9.8	96	2.1	nw.	....	1,470
1.06 a. m.	712.1	2.5	58	nw.	10.3	2,175	577.7	− 8.5	93	2.3	wnw.	....	1,370
1.20 a. m.	712.3	2.4	56	nw.	14.8	1,905	597.8	− 9.8	98	2.1	wnw.	....	1,105
1.43 a. m.	712.5	2.4	56	nw.	10.3	1,438	635.2	− 7.0	100	2.8	wnw.	....	615
1.59 a. m.	712.6	2.4	56	wnw.	10.3	1,083	664.5	− 4.4	97	3.3	wnw.	....	170
2.12 a. m.	712.6	2.3	57	wnw.	9.8	838	685.5	− 1.5	79	3.4	wnw.	....	0
2.20 a. m.	712.6	2.2	58	wnw.	10.3	526	712.6	2.2	58	3.3	wnw.	10.3	......
Sixth flight—													
2.54 a. m.	712.7	2.0	71	wnw.	9.8	526	712.7	2.0	71	3.9	wnw.	9.8	......
3.02 a. m.	712.7	2.0	68	wnw.	11.2	917	678.9	− 1.3	73	3.2	wnw.	13.6	0
3.16 a. m.	712.8	1.9	67	wnw.	12.1	1,367	641.5	− 5.6	87	2.7	wnw.	18.0	470
3.26 a. m.	712.8	1.8	62	nww.	12.1	1,850	602.8	− 9.0	95	2.2	nw.	....	1,105
3.55 a. m.	712.9	1.7	67	wnw.	11.6	2,364	563.9	−12.4	92	1.6	nw.	....	1,635
3.57 a. m.	712.9	1.7	67	wnw.	11.6	2,391	561.7	−12.0	92	1.7	nw.	....	1,640
3.59 a. m.	712.9	1.7	68	wnw.	10.7	2,315	563.9	−12.6	91	1.6	nw.	....	1,600
4.27 a. m.	713.0	1.5	70	wnw.	11.6	1,921	596.9	−10.9	90	1.8	nw.	....	1,080
5.08 a. m.	713.2	1.2	75	wnw.	11.6	1,526	628.5	− 8.0	96	2.4	nw.	....	750
5.39 a. m.	713.4	1.2	73	wnw.	8.0	1,057	667.3	− 3.9	72	2.6	nw.	....	300
5.47 a. m.	713.5	1.3	71	wnw.	8.9	950	676.6	− 3.2	81	3.0	wnw.	....	200
6.03 a. m.	713.6	1.3	71	wnw.	10.3	526	713.6	1.3	71	3.8	wnw.	10.3	......
Seventh flight—													
6.40 a. m.	714.0	1.1	74	nw.	10.7	526	714.0	1.1	74	3.9	nw.	10.7	......
6.50 a. m.	714.1	1.1	74	nw.	12.1	948	677.3	− 3.0	90	3.4	nw.	11.5	170
7.11 a. m.	714.3	1.0	76	nw.	12.1	1,457	635.2	− 5.8	83	2.5	nnw.	12.7	470
7.22 a. m.	714.4	1.0	76	nw.	11.2	1,947	596.4	− 9.7	89	2.0	nnw.	12.1	1,550
7.53 a. m.	714.6	1.0	79	wnw.	8.7	2,474	556.9	−14.1	94	1.4	nnw.	....	2,475
7.55 a. m.	714.7	1.0	79	wnw.	8.7	2,567	550.4	−11.4	94	1.8	nnw.	....	2,475
8.02 a. m.	714.7	1.0	78	wnw.	8.3	2,493	555.8	−13.3	94	1.5	nnw.	....	2,435
8.40 a. m.	715.1	1.0	79	nw.	10.3	2,118	584.1	−10.1	94	2.0	nnw.	....	2,005
8.49 a. m.	715.2	1.0	80	wnw.	8.5	1,852	604.6	− 8.2	96	2.4	nnw.	....	1,880
8.50 a. m.	715.2	1.0	80	wnw.	8.7	1,805	608.2	− 8.3	96	2.4	nnw.	....	1,790
9.05 a. m.	715.3	1.0	82	nw.	8.7	1,169	659.8	− 4.1	98	3.4	nw.	....	530
9.16 a. m.	715.4	1.0	81	nw.	11.2	829	688.8	− 1.8	99	4.2	nw.	....	190
9.25 a. m.	715.5	1.0	82	wnw.	10.3	526	715.5	1.0	82	4.2	wnw.	10.3	......

Fifth flight: Six kites were used; lifting surface, 37.8 sq. m. Wire out, 5,400 m. at maximum altitude, 3,850 m.

St.-Cu., from the west-northwest, varied from 9/10 to 10/10.

November 15, 1912.—Sixth flight: Five kites were used; lifting surface, 31.5 sq. m. Wire out, 5,500 m.; at maximum altitude, 4,500 m.

There were 10/10 St.-Cu., changing in direction from west-northwest to northwest. Light snow fell from 3.26 a. m. to 4.05 a. m.

Seventh flight: Six kites were used; lifting surface, 38.3 sq. m. Wire out, 5,500 m.; at maximum altitude, 4,200 m.

There were 10/10 St.-Cu. from the north-northwest. They lowered in altitude from 1,300 m. at 7.31 a. m. to 1,050 m. at 9.08 a. m. The head kite entered the clouds at 7.26 a. m. and emerged at 9.08 a. m.

At 8.00 a. m. low pressure (754 mm.) was central off the Maine coast. A ridge of high pressure (771 mm.) central over Illinois extended from Mississippi to Lake Superior.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Height	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
Nov. 15, 1912:													
Eighth flight—	*mm.*	°*C.*	%		*m. p. s.*	*m.*	*mm.*	°*C.*	%	*g.cu.m.*		*m. p. s.*	*Volts.*
10.32 a. m..	715.9	1.6	78	nnw.	6.5	526	715.9	1.6	78	4.2	nnw.	6.5	......
10.40 a. m..	716.0	1.7	77	wnw.	6.7	842	688.4	− 1.6	90	3.8	nw.	9.6	0
10.57 a. m..	716.1	1.8	74	wnw.	9.8	1,225	655.8	− 5.1	98	3.2	nw.	9.1	890
11.06 a. m..	716.1	2.0	74	wnw.	9.8	1,823	607.6	− 8.1	91	2.3	nw.	14.3	1,720
11.57 a. m..	715.9	2.0	76	wnw.	8.9	2,466	558.8	−12.6	90	1.5	nnw.	9.3	2,405
12.04 p. m..	715.9	2.1	75	wnw.	9.8	2,780	536.4	− 9.4	50	1.1	nnw.	6.9	......
12.09 p. m..	715.9	2.1	74	wnw.	8.5	2,525	554.5	−13.0	88	1.5	nnw.	7.9	1,705
12.22 p. m..	715.9	2.1	74	wnw.	11.6	2,043	590.4	−10.4	91	1.9	nnw.	9.6	1,290
12.36 p. m..	716.0	2.3	76	wnw.	9.8	1,325	647.6	− 5.0	94	3.0	nnw.	....	795
12.58 p. m..	716.0	2.5	74	nw.	9.8	936	680.3	− 2.1	96	3.9	nnw.	....	460
1.33 p. m..	716.0	2.7	70	nw.	13.0	1,325	647.6	− 5.1	94	3.0	nnw.	13.6	795
1.46 p. m..	716.0	2.5	72	nw.	14.3	856	687.2	1.5	86	3.7	nw.	14.3	425
2.00 p. m..	716.0	2.8	63	nw.	11.6	526	716.0	2.8	63	3.7	nw.	11.6	......
Ninth flight—													
2.37 p. m...	716.4	2.7	73	wnw.	14.3	526	716.4	2.7	73	4.2	wnw.	14.3	......
2.54 p. m...	716.5	2.7	73	nw.	15.6	888	685.0	− 2.1	87	3.6	nw.	14.9	0
3.07 p. m...	716.6	2.4	73	wnw.	15.2	1,391	642.9	− 5.2	65	2.1	nnw.	18.6	1,510
3.18 p. m...	716.7	2.5	68	wnw.	13.4	2,316	570.7	−12.1	85	1.5	nnw.	13.0	2,090
3.20 p. m...	716.7	2.4	69	wnw.	13.4	2,463	560.0	− 8.8	60	1.4	nnw.	13.6	2,005
4.21 p. m...	717.2	1.6	73	wnw.	16.1	2,997	522.8	− 9.1	31	0.7	nnw.	7.3	......
4.53 p. m...	717.7	1.0	77	wnw.	12.5	2,725	541.8	− 6.7	27	0.8	nnw.	10.7	2,555
5.08 p. m...	717.8	0.8	79	wnw.	13.4	2,318	570.7	− 7.8	28	0.7	nnw.	13.1	1,555
5.10 p. m...	717.8	0.7	80	wnw.	13.4	2,175	581.6	−11.5	30	0.6	nnw.	13.1	1,505
5.26 p. m...	717.9	0.5	81	wnw.	13.9	1,574	628.7	− 8.6	85	2.1	nnw.	15.5	1,175
5.36 p. m...	717.9	0.2	81	wnw.	12.1	1,398	642.9	− 8.6	96	2.5	nnw.	16.7	1,010
5.54 p. m...	718.0	0.3	87	wnw.	13.0	889	686.1	− 3.1	91	3.4	nw.	18.0	330
6.03 p. m...	718.0	0.3	85	wnw.	13.0	526	718.0	0.3	85	4.2	wnw.	13.0	......
Nov. 22, 1912:													
10.08 a. m..	715.8	14.0	44	wsw.	7.2	526	715.8	14.0	44	5.3	wsw.	7.2	......
10.24 a. m..	715.8	14.5	41	sw.	5.8	887	685.8	10.5	45	4.3	wsw.	7.1	0
10.47 a. m..	715.8	14.2	42	wsw.	5.8	1,305	652.0	6.5	57	4.3	w.	13.0	0
11.01 a. m..	715.8	14.1	41	wsw.	5.4	1,718	620.1	4.6	61	4.0	w.	19.2	860
11.03 a. m..	715.8	14.1	42	wsw.	4.0	1,872	608.5	5.5	52	3.6	w.	19.8	880
11.07 a. m..	715.7	14.2	40	wsw.	4.0	1,966	601.5	5.3	42	2.9	wnw.	18.6	890
11 21 a. m..	715.5	14.2	36	sw.	3.6	2,639	553.4	1.3	41	2.2	w.	21.7	1,350
11.36 a. m..	715.3	15.0	36	sw.	4.5	3,205	515.5	− 3.7	32	1.2	w.	19.8	1,280
11.48 a. m..	715.1	15.0	39	sw.	6.3	3,520	495.0	− 7.1	36	1.0	w.	20.5	1,470
12.01 p. m..	714.9	15.0	39	sw.	4.5	3,343	506.2	− 5.2	39	1.2	w.	20.0	1,360
12.14 p. m..	714.8	15.9	38	sw.	5.8	2,881	536.6	− 0.9	48	2.2	w.	17.4	1,140
12.24 p. m..	714.7	15.6	40	sw.	7.6	2,353	572.7	3.6	38	2.3	wnw.	17.5	83
12.30 p. m..	714.7	15.6	41	wsw.	4.5	2,015	597.0	3.4	36	2.2	wnw.	18.0	6400
12.38 p. m..	714.6	16.0	41	sw.	5.8	1,769	615.5	4.2	48	3.1	w.	15.2	......
12.50 p. m..	714.6	15.9	43	sw.	4.5	1,045	671.9	9.9	57	5.3	w.	5.0	......
12.56 p. m..	714.5	15.8	49	sw.	6.7	526	714.5	15.8	49	6.5	sw.	6.7	......

Eighth flight: Six kites were used; lifting surface, 37.8 sq. m. Wire out, 5,000 m.; at maximum altitude, 4,500 m.

There were 10/10 St.-Cu., changing from the northwest to north-northwest. The head kite entered St.-Cu., altitude 1,200 m., at 10.51 a. m. and emerged at 1.39 p. m.

Ninth flight: Five kites were used; lifting surface, 31.5 sq. m. Wire out, 6,500 m.; at maximum altitude, 6,300 m.

Ci.-St. and A.-Cu., from the northwest, and St.-Cu., from the north-northwest, varied from 2/10 to 8/10.

November 22, 1912.—Five kites were used; lifting surface, 32.0 sq. m. Wire out, 4,800 m. at maximum altitude.

There were 9/10 to 7/10 Ci., A.-St., and A.-Cu. from the west before 12.30 p. m.; thereafter St.-Cu. from the west increased from 2/10 to 10/10.

High pressure (767 mm.) was central off the South Atlantic coast and low pressure (753 mm.) was central over the lower St. Lawrence Valley.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Height	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
Dec. 6, 1912:													
First flight—	*mm.*	*°C.*	*%*		*m. p. s.*	*m.*	*mm.*	*°C.*	*%*	*g. cu. m.*		*m. p. s.*	*Volts.*
8.57 a. m.	714.8	15.1	90	w.	8.0	526	714.8	15.1	90	11.5	w.	8.0	......
9.12 a. m.	714.9	15.6	87	w.	8.9	939	681.0	14.0	82	9.8	wnw.	10.3	0
9.29 a. m.	714.9	15.8	86	wsw.	8.9	1,492	637.6	9.4	94	8.4	w.	16.9	0
9.40 a. m.	715.0	15.7	87	wsw.	8.5	1,994	600.1	6.7	100	7.6	w.	19.2	0
9.58 a. m.	715.1	15.6	88	w.	8.0	2,601	557.4	5.2	59	4.0	w.	20.5	0
9.59 a. m.	715.1	15.6	88	w.	8.0	2,617	556.3	4.2	62	4.0	w.	20.5	0
10.02 a. m.	715.1	15.6	88	w.	8.0	2,695	551.0	6.5	50	3.7	w.	19.8	0
10.13 a. m.	715.1	15.7	87	w.	8.5	3,001	531.0	5.9	36	2.6	w.	20.4	0
10.24 a. m.	715.1	15.7	87	w.	9.8	3,443	502.8	3.3	22	1.3	w.	18.6	0
10.33 a. m.	715.1	15.9	86	w.	9.8	3,226	516.2	4.0	18	1.1	w.	18.0	0
10.44 a. m.	715.1	16.5	86	w.	8.9	2,771	545.6	8.7	16	1.4	w.	18.6	0
10.46 a. m.	715.1	16.5	86	w.	9.8	2,739	547.7	3.4	24	1.5	w.	18.6	0
10.48 a. m.	715.1	16.5	86	w.	8.0	2,705	549.9	6.0	24	1.7	w.	18.3	0
10.49 a. m.	715.1	16.5	86	w.	8.0	2,609	556.3	3.4	39	2.4	w.	18.3	0
10.55 a. m.	715.1	16.4	86	w.	8.0	2,454	567.1	4.8	72	4.8	w.	15.2	0
10.56 a. m.	715.1	16.4	86	w.	8.0	2,393	571.3	4.0	82	5.2	w.	15.2	0
10.58 a. m.	715.1	16.3	86	w.	6.7	2,317	576.8	5.3	81	5.6	w.	15.2	0
10.59 a. m.	715.1	16.3	86	w.	6.7	2,286	578.9	4.6	90	5.9	w.	15.2	0
11.00 a. m.	715.1	16.3	86	w.	6.7	2,225	583.3	5.0	86	5.8	w.	15.2	0
11.02 a. m.	715.1	16.3	86	w.	6.7	2,193	585.6	4.5	93	6.1	w.	16.7	0
11.03 a. m.	715.1	16.3	86	w.	6.7	2,178	586.7	5.5	89	6.2	w.	16.7	0
11.05 a. m.	715.1	16.3	86	w.	6.7	2,164	587.8	4.1	98	6.2	w.	17.4	0
11.20 a. m.	715.1	17.0	81	w.	6.7	1,523	635.3	8.8	90	7.8	w.	16.7	0
11.33 a. m.	715.0	17.2	80	w.	7.2	1,001	676.2	12.9	79	8.8	w.	13.8	0
11.42 a. m.	715.0	17.4	77	w.	8.0	526	715.0	17.4	77	11.3	w.	8.0	......
Second flight—													
12.15 p. m.	714.8	18.0	77	w.	6.7	526	714.8	18.0	77	11.7	w.	6.7	......
12.27 p. m.	714.7	18.0	70	w.	8.5	960	680.0	13.6	79	9.2	w.	12.4	0
12.44 p. m.	714.6	18.1	62	w.	10.3	1,438	641.4	8.6	90	7.7	w.	17.4	0
1.00 p. m.	714.4	17.8	64	w.	11.2	2,006	598.2	3.6	97	6.0	w.	20.5	0
1.07 p. m.	714.4	17.9	63	w.	11.2	2,296	577.3	1.3	99	5.2	w.	20.7	0
1.10 p. m.	714.4	17.9	63	w.	10.3	2,418	568.7	7.7	57	4.6	w.	23.8	0
1.11 p. m.	714.3	17.9	63	w.	10.3	2,492	563.4	0.9	67	3.4	w.	25.7	......
1.16 p. m.	714.3	17.9	69	w.	10.3	2,603	555.8	6.9	35	2.7	wnw.	....	0
1.20 p. m.	714.3	17.9	70	w.	8.9	2,635	553.7	4.2	28	1.8	wnw.	....	0
1.21 p. m.	714.3	17.9	69	w.	8.9	2,689	549.4	6.0	26	1.9	wnw.	....	20
1.25 p. m.	714.3	18.0	69	w.	8.9	2,855	539.0	3.8	23	1.4	wnw.	....	105
1.36 p. m.	714.2	18.0	68	w.	8.5	3,022	528.3	4.6	15	1.0	wnw.	....	170
1.46 p. m.	714.2	18.2	68	w.	8.0	2,788	544.0	5.9	11	0.8	wnw.	....	125
1.50 p. m.	714.2	18.2	68	w.	8.9	2,706	549.4	3.9	11	0.7	wnw.	....	95
1.56 p. m.	714.1	18.4	68	w.	8.9	2,674	551.5	6.2	11	0.8	wnw.	....	75
2.08 p. m.	714.1	18.6	66	w.	8.0	2,457	566.6	0.2	87	4.3	wnw.	15.0	0
2.17 p. m.	714.1	18.6	63	w.	9.4	2,319	576.2	5.9	49	3.5	wnw.	....	0
2.19 p. m.	714.1	18.6	63	w.	10.7	2,166	587.1	5.1	52	3.5	wnw.	....	0
2.25 p. m.	714.1	18.4	63	w.	11.2	1,807	613.2	8.2	50	4.2	w.	17.7	0
2.35 p. m.	714.2	18.2	64	w.	9.4	1,359	647.3	10.2	71	6.7	w.	14.7	0
2.48 p. m.	714.2	17.5	65	wnw.	8.9	885	684.8	14.8	63	7.9	w.	11.2	0
2.55 p. m.	714.2	17.4	64	w.	8.0	526	714.2	17.4	64	9.4	w.	8.0	......

December 6, 1912.—First flight: Five kites were used; lifting surface, 31.5 sq. m. Wire out, 5,000 m. at maximum altitude.

Ci. and St.-Cu., from the west, decreased from 9/10 to 7/10. The head kite was in St.-Cu., altitude 1,500 m., at intervals between 9.30 and 9.34 a. m.

Low pressure (749 mm.) was central over western Quebec. High pressure (780 mm.) central over Washington dominated conditions east of the Mississippi River.

Second flight: Four kites were used; lifting surface, 25.2 sq. m. Wire out, 5,000 m. at maximum altitude.

Ci. and St.-Cu., from the west, varied from 10/10 to a few. The head kite was in St.-Cu., altitude 2,000 m., at 1 p. m.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Height	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
Dec. 6, 1912:													
Third flight—	*mm.*	*°C.*	*%*		*m. p. s.*	*m.*	*mm.*	*°C.*	*%*	*g.cu.m.*		*m. p. s.*	*Volts.*
3.28 p.m...	714.2	18.6	58	w.	8.5	526	714.2	18.6	58	9.1	w.	8.5	......
3.37 p.m...	714.2	18.4	60	w.	8.9	974	677.6	14.0	55	6.6	w.	14.4	0
3.50 p.m...	714.2	18.1	53	w.	10.3	1,482	637.7	9.4	52	4.7	w.	19.2	0
4.06 p.m...	714.2	17.8	54	w.	8.9	2,071	593.7	3.7	61	3.8	wnw.	19.2	0
4.12 p.m...	714.3	17.6	55	w.	8.0	2,242	581.6	5.5	37	2.6	wnw.	26.4	30
4.23 p.m...	714.4	17.2	57	w.	8.9	2,687	550.4	2.4	22	1.3	nw.	25.4	170
4.31 p.m...	714.4	17.0	54	w.	10.3	3,243	513.8	−1.2	18	0.8	nw.	23.6	330
4.55 p.m...	714.6	16.4	53	w.	8.9	2,608	555.8	2.7	14	0.8	nw.	24.2	170
5.02 p.m...	714.6	16.3	52	w.	9.8	2,531	561.1	3.6	13	0.8	nw.	22.4	145
5.05 p.m...	714.6	16.3	52	w.	8.9	2,455	566.5	3.6	12	0.7	wnw.	....	115
5.13 p.m...	714.6	16.2	51	w.	7.6	2,164	587.0	5.2	13	0.9	wnw.	19.8	5
5.15 p.m...	714.6	16.1	51	w	7.6	2,150	588.1	4.6	14	0.9	wnw.	19.8	0
5.32 p.m...	714.7	15.4	50	w.	6.9	1,468	638.9	7.9	40	3.3	wnw.	13.6	0
5.44 p.m...	714.7	15.0	50	w.	6.3	948	679.9	12.7	44	4.9	wnw.	15.5	0
5.52 p.m...	714.8	14.6	50	w.	6.3	526	714.8	14.6	50	6.2	w.	6.3	......
Fourth flight—													
6.22 p.m...	714.9	14.4	50	wnw.	12.5	526	714.9	14.4	50	6.1	wnw.	12.5	......
6.31 p.m...	715.0	14.4	48	wnw.	16.1	901	684.0	12.5	45	4.9	wnw.	18.8	0
6.45 p.m...	715.0	14.3	49	wnw.	16.5	1,327	650.0	8.7	43	3.7	wnw.	18.6	0
6.52 p.m...	715.1	14.2	49	wnw.	15.2	1,725	619.4	5.9	48	3.4	wnw.	22.0	0
6.55 p.m...	715.1	14.2	49	wnw.	12.5	2,023	597.4	8.1	34	2.8	wnw.	19.8	0
7.14 p.m...	715.2	13.8	50	wnw.	....	2,846	540.1	0.9	21	1.1	wnw.	19.8	260
7.25 p.m...	715.4	13.1	52	w.	5.8	2,503	563.6	3.8	18	1.1	wnw.	16.7	260
7.30 p.m...	715.4	13.2	52	w.	5.4	2,941	534.0	2.2	16	0.9	wnw.	19.2	405
7.33 p.m...	715.4	13.2	52	w.	8.5	3,028	527.5	3.2	13	0.8	wnw.	22.9	440
7.35 p.m...	715.5	13.3	52	w.	9.8	3,118	522.2	2.9	12	0.7	wnw.	26.0	460
7.42 p.m...	715.5	13.2	52	w.	9.8	3,009	528.6	3.9	11	0.7	wnw.	21.2	410
7.50 p.m...	715.6	13.0	53	wnw.	9.8	2,995	529.6	2.5	10	0.6	wnw.	20.0	410
8.02 p.m...	715.7	12.9	53	wnw.	8.9	2,680	550.7	2.2	9	0.5	wnw.	19.7	255
8.13 p.m...	715.8	12.9	53	wnw.	10.3	2,218	583.0	5.1	9	0.6	wnw.	19.7	70
8.17 p.m...	715.8	12.9	53	wnw.	8.9	1,970	600.9	4.7	9	0.6	wnw.	23.6	0
8.22 p.m...	715.9	12.6	52	wnw.	8.5	1,941	603.1	2.4	9	0.5	wnw.	19.6	0
8.37 p.m...	716.0	12.4	56	wnw.	7.4	1,436	641.8	5.7	25	1.8	wnw.	14.4	0
8.50 p.m...	716.1	11.8	56	wnw.	6.7	953	680.4	9.6	40	3.6	wnw.	13.0	0
8.57 p.m...	716.2	11.6	51	nw.	6.7	526	716.2	11.6	51	5.3	nw.	6.7	......
Fifth flight—													
9.25 p.m..	716.2	11.2	52	wnw.	7.8	526	716.2	11.2	52	5.2	wnw.	7.8	......
9.34 p.m..	716.2	11.6	49	wnw.	8.9	938	681.7	9.2	49	4.3	wnw.	12.4	0
9.48 p.m..	716.2	11.3	49	wnw.	11.2	1,448	640.8	5.4	50	3.5	wnw.	14.3	0
9.55 p.m.	716.2	11.2	44	wnw.	11.2	1,754	617.2	3.6	41	2.5	wnw.	18.6	0
9.58 p.m..	716.2	11.3	43	wnw.	11.2	1,907	605.6	5.7	37	2.6	wnw.	21.1	5
10.16 p.m..	716.2	10.9	45	wnw.	8.5	2,730	547.3	0.8	25	1.3	wnw.	23.1	405
10.21 p.m..	716.2	10.8	45	wnw.	8.0	3,010	528.5	2.0	23	1.3	w.	26.8	565
10.30 p.m..	716.2	10.8	44	wnw.	9.4	3,420	503.2	0.0	20	1.0	w.	....	680
10.51 p.m..	716.1	9.7	46	wnw.	6.5	2,948	532.7	2.5	16	0.9	w.	....	506
10.53 p.m..	716.1	9.6	46	wnw.	6.5	2,789	543.1	2.3	16	0.9	w.	18.2	440
10.55 p.m..	716.1	9.3	47	wnw.	7.2	2,726	547.3	1.0	17	0.9	w.	18.2	415
11.13 p.m..	716.1	9.3	47	wnw.	7.6	2,265	579.6	4.2	18	1.2	w.	18.5	180
11.26 p.m..	716.1	9.1	47	wnw.	6.5	1,810	612.6	6.7	17	1.3	w.	....	0
11.38 p.m..	716.1	8.7	48	wnw.	5.6	1,426	641.9	4.2	54	3.5	w.	17.3	0
11.52 p.m..	716.1	9.0	46	wnw.	7.6	920	682.8	7.3	33	2.6	wnw.	11.6	0
12.00 midnight....	716.1	8.6	48	wnw.	5.8	526	716.1	8.6	48	4.1	wnw.	5.8	......

Third flight: Five kites were used; lifting surface, 31.5 sq. m. Wire out, 4,800 m., at maximum altitude.

Ci. and St.-Cu., from the west, varied from 1/10 to a few.

Fourth flight: Five kites were used; lifting surface, 31.5 sq. m. Wire out, 5,000 m., at maximum altitude.

There were a few St.-Cu. from the west-northwest after 7.15 p. m.

Fifth flight: Five kites were used; lifting surface, 31.5 sq. m. Wire out, 5,000 m., at maximum altitude.

St.-Cu., from the west-northwest, increased from 1/10 to 6/10.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Height	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
Dec. 7, 1912:													
Sixth flight—	*mm.*	*°C.*	*%*		*m. p. s.*	*m.*	*mm.*	*°C.*	*%*	*g.cu.m.*		*m. p. s.*	*Volts.*
12.22 a. m..	716.0	8.0	49	nw.	9.8	526	716.0	8.0	49	4.0	nw.	9.8	......
12.32 a. m..	715.9	7.8	51	nw.	11.2	918	682.8	7.6	48	3.8	wnw.	15.2	0
12.37 a. m..	715.9	8.0	49	nw.	11.6	1,175	661.8	5.8	45	3.2	wnw.	18.9	0
12.44 a. m..	715.9	7.7	52	nw.	11.6	1,276	653.6	5.9	38	2.7	wnw.	22.6	0
12.50 a. m..	715.9	7.4	52	nw.	13.4	1,517	634.8	8.4	31	2.6	wnw.	22.6	125
1.00 a. m..	715.8	7.1	56	nw.	15.2	1,813	612.5	7.8	28	2.3	wnw.	20.0	205
1.11 a. m..	715.7	6.7	59	nw.	16.1	2,433	567.8	3.5	30	1.8	w.	18.8	330
1.24 a. m..	715.6	6.5	60	nw.	16.1	3,156	518.9	−2.7	30	1.2	w.	18.0	745
1.25 a. m..	715.6	6.5	60	nw.	16.1	3,217	514.8	−2.8	30	1.2	w.	18.0	760
1.29 a. m..	715.5	6.4	61	nw.	16.5	3,328	507.6	−4.0	29	1.0	w.	20.5	780
1.30 a. m..	715.5	6.4	61	nw.	16.5	3,295	509.7	−3.4	28	1.0	w.	18.6	780
1.40 a. m..	715.4	6.3	62	nw.	19.7	3,197	515.9	−3.4	28	1.0	w.	15.0	750
2.01 a. m..	715.2	6.0	64	nw.	20.6	2,277	578.5	4.7	33	2.2	w.	17.7	430
2.11 a. m..	715.2	5.7	64	nw.	21.5	1,777	614.8	8.1	32	2.6	wnw.	19.6	170
2.15 a. m..	715.2	5.6	65	nw.	19.7	1,621	626.5	8.1	30	2.5	wnw.	22.7	90
2.21 a. m..	715.1	5.4	67	nw.	20.6	1,326	648.9	9.6	26	2.4	wnw.	22.9	0
2.52 a. m..	715.0	5.0	63	nw.	21.9	698	700.1	5.9	39	2.8	nw.	....	0
2.54 a. m..	715.0	5.0	64	nw.	21.5	632	705.8	3.8	44	2.7	nw.	....	0
3.02 a. m..	715.0	4.8	65	nw.	21.5	526	715.0	4.8	65	4.3	nw.	21.5	......
Seventh flight—													
3.33 a. m...	715.1	4.2	65	nw.	15.6	526	715.1	4.2	65	4.2	nw.	15.6	......
3.42 a. m...	715.1	4.0	65	nw.	17.0	960	678.0	3.8	56	3.5	w.	18.6	0
3.46 a. m...	715.1	4.0	64	nw.	14.3	1,175	660.4	5.9	43	3.1	w.	23.9	0
3.56 a. m...	715.1	3.9	64	nw.	14.8	1,414	641.6	6.7	28	2.1	w.	25.2	80
4.02 a. m...	715.1	3.7	64	nw.	15.6	1,813	611.1	5.2	26	1.8	w.	23.4	260
4.15 a. m...	715.1	3.5	63	nw.	16.5	2,523	560.3	5.0	30	2.0	w.	24.7	660
4.23 a. m...	715.1	3.3	61	nw.	17.0	2,836	539.2	2.6	30	1.7	w.	....	890
4.31 a. m...	715.2	3.1	62	nw.	17.9	2,559	558.2	4.9	30	2.0	w.	....	835
4.47 a. m...	715.2	2.9	62	nw.	17.4	2,097	590.7	6.2	34	2.5	w.	....	760
5.26 a. m...	715.4	2.2	66	nw.	17.4	1,416	641.6	8.5	20	1.7	w.	....	125
5.45 a. m...	715.5	1.8	68	nw.	18.8	1,078	668.6	5.5	34	2.4	w.	20.2	0
5.48 a. m...	715.5	1.8	68	nw.	17.9	924	681.4	3.9	32	2.0	w.	17.1	0
5.55 a. m...	715.6	1.8	68	nw.	14.3	842	688.4	4.5	33	2.2	w.	17.5	0
6.03 a. m...	715.6	1.8	68	nnw.	14.3	526	715.6	1.8	68	3.7	nnw.	14.3	......
Eighth flight—													
6.33 a. m...	716.0	1.8	68	nw.	12.5	526	716.0	1.8	68	3.7	nw.	12.5	......
6.37 a. m...	716.0	1.6	70	nw.	12.5	768	695.0	4.3	62	4.0	w.	15.6	0
6.47 a. m...	716.1	1.6	70	nw.	13.4	974	677.7	3.2	50	3.0	w.	17.1	15
6.52 a. m...	716.2	1.7	69	nw.	13.4	1,334	648.4	4.3	63	4.1	w.	21.7	165
7.04 a. m...	716.3	1.5	70	nw.	12.1	1,560	630.7	3.2	66	4.0	w.	16.2	235
7.08 a. m...	716.4	1.4	70	nw.	10.7	1,855	608.4	4.5	49	3.2	w.	23.6	535
7.20 a. m...	716.5	1.4	70	nw.	12.1	2,103	590.5	3.0	42	2.5	w.	24.3	1,140
7.38 a. m...	716.6	1.4	70	nw.	14.8	2,554	558.2	−0.1	51	2.4	wsw.	25.1	1,530
7.42 a. m...	716.7	1.4	70	nw.	11.2	2,935	531.7	−1.0	51	2.3	wsw.	....	......
7.56 a. m...	716.8	1.8	68	nw.	11.6	2,384	568.9	0.7	52	2.6	wsw.	....	1,590
8.48 a. m...	717.3	1.6	67	nw.	11.2	1,966	599.4	2.6	......	....	wsw.	....	1,140
9.02 a. m...	717.4	1.6	67	nw.	8.0	1,575	629.5	−1.8	55	2.3	w.	18.3	460
9.22 a. m...	717.7	1.7	63	nw.	8.7	877	687.0	1.8	57	3.1	w.	12.4	0
9.28 a. m...	717.8	1.7	63	nw.	8.0	811	692.8	−0.7	61	2.8	w.	9.8	0
9.32 a. m...	717.8	1.7	63	nw.	7.6	526	717.8	1.7	63	3.4	nw.	7.6	......

December 7, 1912.—Sixth flight: Four kites were used; lifting surface, 25.2 sq. m. Wire out, 5,200 m., at maximum altitude.

St.-Cu., from the west-northwest, increased from 6/10 to 8/10.

Seventh flight: Four kites were used; lifting surface, 25.2 sq. m. Wire out, 5,000 m., at maximum altitude.

St.-Cu., from the west, varied from 6/10 to 10/10.

Eighth flight: Five kites were used; lifting surface, 30.5 sq. m. Wire out, 5,500 m.; at maximum altitude, 5,400 m.

There were 10/10 A.-St. and St.-Cu. from the west.

At 8 a. m. low pressure (743 mm.) was central over Newfoundland. High pressure (778 mm.) central over Washington dominated conditions east of the Mississippi.

Results of free air observations.

Date and hour.	On Mount Weather, Va., 526 m.					At different heights above sea.							
	Pressure.	Temperature.	Rel. hum.	Wind.		Height	Pressure.	Temperature.	Humidity.		Wind.		P. D. kite and earth.
				Dir.	Vel.				Rel.	Abs.	Dir.	Vel.	
Dec. 7, 1912:													
Ninth flight—	*mm.*	*°C.*	*%*		*m. p. s.*	*m.*	*mm.*	*°C.*	*%*	*g.cu.m.*		*m. p. s.*	*Volts.*
9.56 a. m.	718.1	1.8	64	nw.	8.5	526	718.1	1.8	64	3.5	nw.	8.5	......
10.05 a. m.	718.2	1.9	64	nw.	8.5	844	690.3	−1.2	74	3.3	w.	11.0	0
10.06 a. m.	718.2	1.9	64	nw.	8.5	1,019	675.3	0.6	70	3.5	w.	19.7	0
10.21 a. m.	718.2	2.2	64	nw.	7.6	1,447	640.1	−3.6	79	2.9	w.	21.7	540
10.32 a. m.	718.1	2.0	64	nw.	8.7	2,076	591.4	1.0	60	3.1	wsw.	27.4	1,080
10.40 a. m.	718.1	2.3	63	nw.	11.2	2,380	569.6	−0.6	74	3.4	wsw.	31.0	1,320
10.48 a. m.	718.1	2.3	63	nw.	12.5	2,548	557.7	−2.7	82	3.2	wsw.	....	1,350
10.57 a. m.	718.1	2.3	63	nw.	12.5	2,689	548.1	−3.0	97	3.7	wsw.	25.2	......
11.20 a. m.	717.9	2.5	60	nw.	13.0	2,357	571.6	−1.7	52	2.2	wsw.	....	610
11.24 a. m.	717.8	2.5	60	nw.	13.4	2,236	580.3	−2.4	44	1.8	wsw.	23.1	400
11.27 a. m.	717.8	2.5	60	nw.	13.4	2,070	592.5	0.4	38	1.9	wsw.	....	120
11.40 a. m.	717.6	2.6	59	nw.	14.8	1,687	621.2	−0.1	34	1.6	w.	18.3	0
11.54 a. m.	717.5	2.7	60	nw.	15.2	1,342	648.3	2.0	68	3.8	w.	17.5	0
12.00 noon.	717.4	2.8	61	nw.	11.2	1,054	671.8	−0.1	61	2.9	w.	16.1	0
12.04 p. m.	717.4	2.8	61	nw.	11.2	1,040	673.0	1.2	60	3.1	w.	18.6	0
12.08 p. m.	717.3	2.9	59	nw.	11.2	849	689.2	0.4	60	3.0	w.	14.2	0
12.14 p. m.	717.3	3.1	56	nw.	9.4	526	717.3	3.1	56	3.3	w.	9.4	......
Tenth flight—													
12.38 p. m.	717.1	3.5	52	nw.	8.9	526	717.1	3.5	52	3.2	nw.	8.9	......
12.50 p. m.	717.0	4.2	51	nw.	10.7	1,009	675.5	0.5	55	2.8	w.	15.5	0
12.51 p. m.	717.0	4.2	51	nw.	10.7	1,035	673.3	1.3	55	2.9	w.	15.5	0
1.03 p. m.	716.9	4.5	52	wnw.	9.4	1,586	628.6	−0.3	62	2.9	w.	23.6	820
1.19 p. m.	716.8	4.8	51	wnw.	11.2	2,340	571.7	−5.0	73	2.4	wsw.	23.0	1,390
1.25 p. m.	716.8	4.9	51	wnw.	9.4	2,594	553.5	−3.5	76	2.8	wsw.	27.3	1,560
1.30 p. m.	716.8	5.0	51	wnw.	10.3	2,872	534.5	−4.5	70	2.4	w.	31.0	1,755
1.42 p. m.	716.7	5.2	51	wnw.	9.4	3,188	513.4	−4.6	80	2.7	w.	....	1,985
4.03 p. m.	716.5	5.2	51	......	5.4	526	716.5	5.2	51	3.5	......	5.4	......
Dec. 16, 1912:													
8.28 a. m.	711.9	4.6	76	nw.	12.1	526	711.9	4.6	76	5.0	nw.	12.1	......
8.35 a. m.	712.0	4.6	77	wnw.	13.4	930	677.4	0.2	85	4.2	wnw.	18.9	0
8.44 a. m.	712.0	4.8	78	wnw.	17.4	1,384	640.0	−1.4	84	3.6	nw.	22.1	920
8.53 a. m.	712.1	4.7	77	wnw.	17.0	1,444	635.3	2.9	66	3.9	nw.	18.1	......
8.55 a. m.	712.2	4.8	77	wnw.	17.9	1,567	625.8	2.6	62	3.6	nw.	17.3	......
8.59 a. m.	712.2	4.8	76	wnw.	17.9	1,659	618.8	3.8	54	3.4	nw.	17.3	......
9.02 a. m.	712.2	4.9	76	wnw.	17.9	1,784	609.4	2.5	51	2.9	nw.	17.3	......
9.17 a. m.	712.1	4.8	75	nw.	19.7	1,357	642.3	4.0	51	3.2	nw.	22.2	......
9.19 a. m.	712.1	4.8	75	nw.	18.8	1,298	647.0	−0.4	61	2.9	nw.	23.0	......
9.24 a. m.	712.1	4.9	75	nw.	18.8	1,182	656.4	0.5	78	3.9	nw.	25.5	......
9.25 a. m.	712.1	4.9	75	nw.	19.7	1,125	661.1	−1.2	84	3.7	nw.	25.5	......
9.41 a. m.	712.1	5.0	75	nw.	24.1	931	677.4	0.6	100	5.0	nw.	23.8	0
9.50 a. m.	712.0	5.4	72	nw.	22.4	526	712.0	5.4	72	5.0	nw.	22.4	......

Ninth flight: Three kites were used; lifting surface, 18.9 sq. m. Wire out, 4,500 m.; at maximum altitude, 4,450 m.

There were from 10/10 to 9/10 A.-St. and St.-Cu. from the west.

Tenth flight: Four kites were used; lifting surface, 24.2s q. m. Wire out, 6,000 m. at maximum altitude.

There were 9/10 A.-St. and St.-Cu. from the west before 1.40 p. m. Thereafter, there were 8/10 Ci.-St. and St.-Cu. from the west. A solar halo was observed at 2.38 p. m.

December 16, 1912.—Three kites were used; lifting surface, 17.9 sq. m. Wire out, 2,700 m.; at maximum altitude, 2,150 m.

There were 8/10 to 7/10 St.-Cu. from the northwest, altitude about 1,200 m.

A ridge of high pressure central over Indiana (765 mm.) and over northern Georgia (765 mm.) extended from the Gulf of Mexico to the Great Lakes.

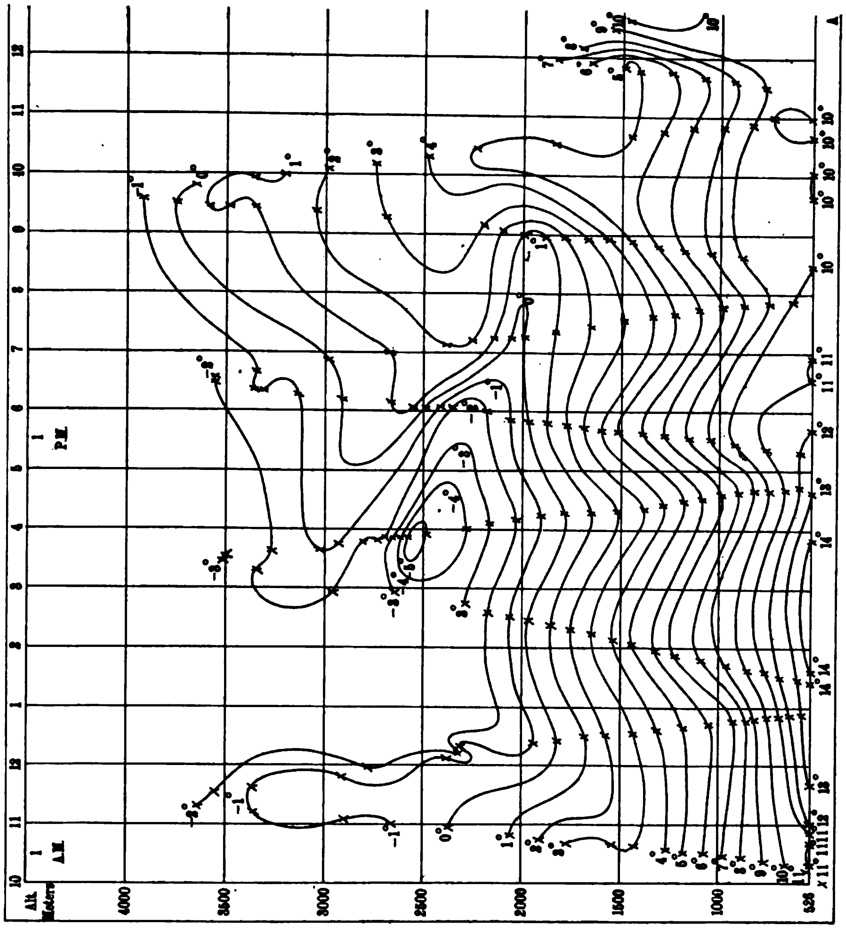

FIG. 24a.—Free air isotherms above Mount Weather; observed Oct. 1, 2, 1912.

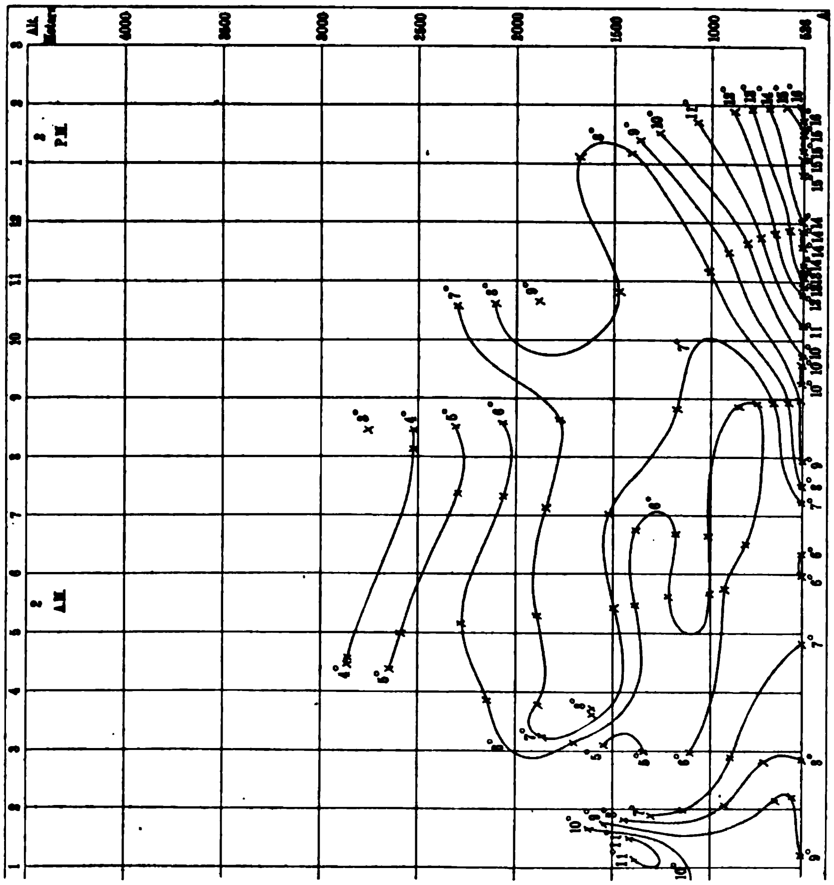

FIG. 24b.—Free air isotherms a bove Mount Weather; observed Oct. 1, 2, 1912.

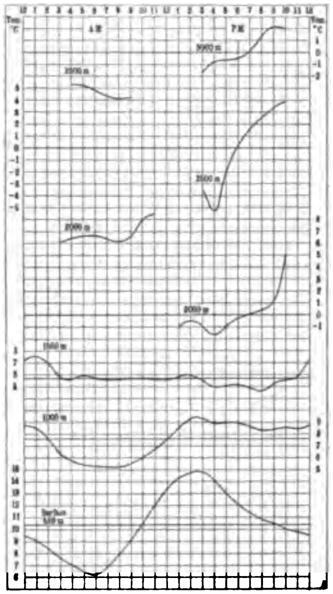

FIG. 25.—Smoothed diurnal curves of temperature above Mount Weather; observed 12.30 p. m., Oct. 1 to 12.30 p. m., Oct. 2, 1912.

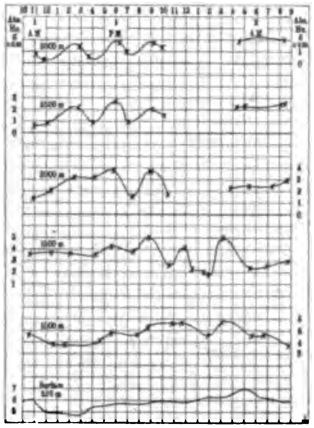

FIG. 26.—Absolute humidities above Mount Weather; observed Oct. 1, 2, 1912.

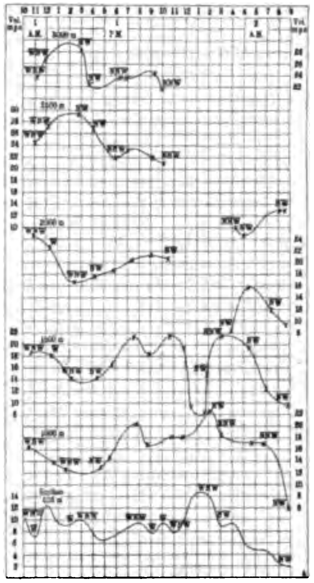

FIG. 27.—Wind velocities and directions above Mount Weather; observed Oct. 1, 2, 1912.

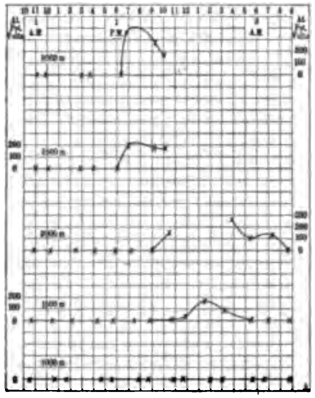

FIG. 28.—Atmospheric electric potentials above Mount Weather; observed Oct. 1, 2, 1912.

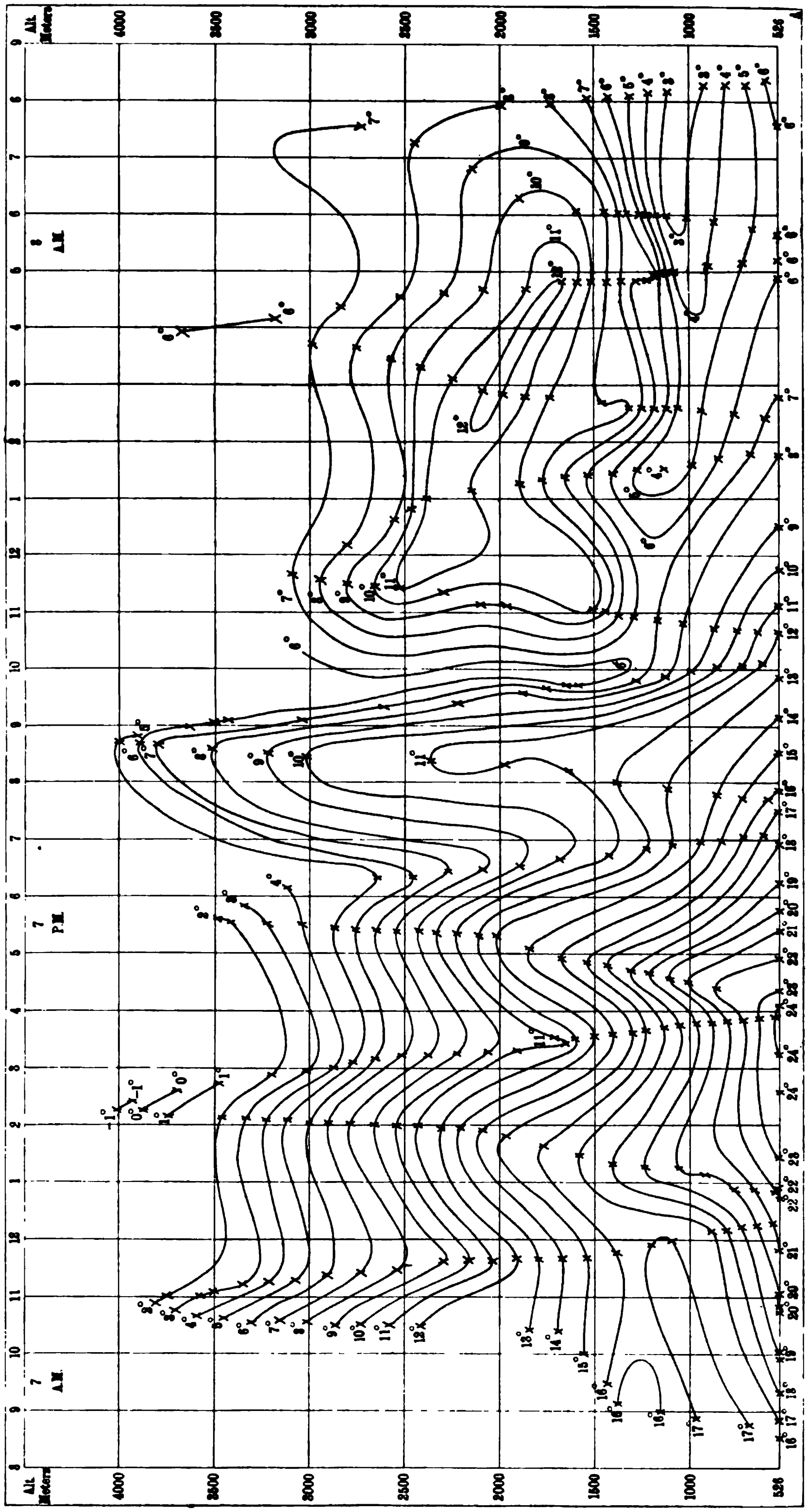

FIG. 29.—Free air isotherms above Mount Weather; observed Oct. 7, 8, 1912.

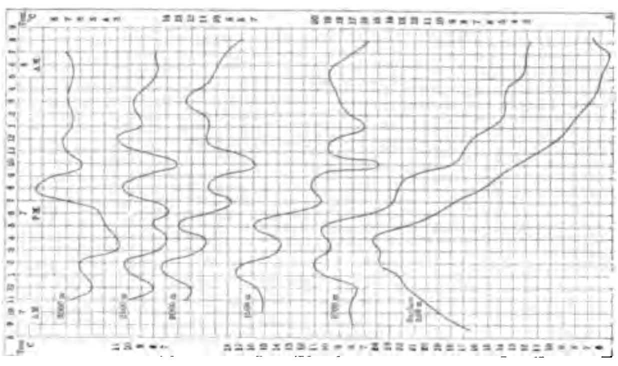

FIG. 30.—Temperatures above Mount Weather; observed Oct. 7, 8, 1912.

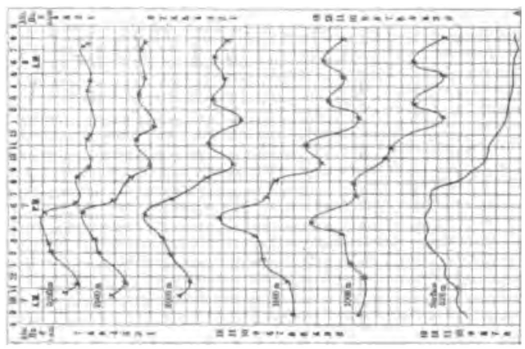

FIG. 31.—Absolute humidities above Mount Weather; observed Oct. 7, 8, 1912.

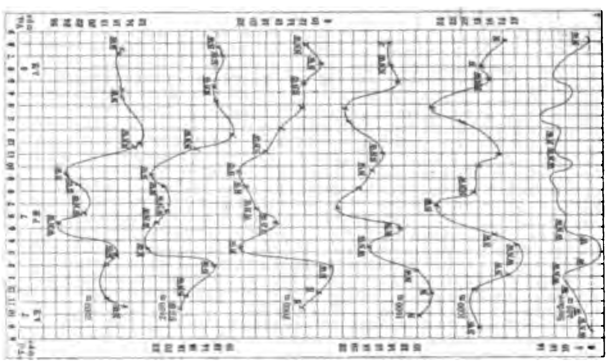

FIG. 32.—Wind velocities and directions above Mount Weather; observed Oct. 7, 8, 1912.

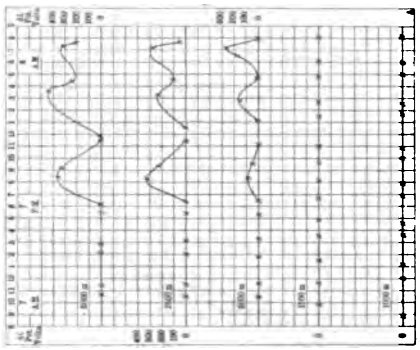

FIG. 33.—Atmospheric electric potentials above Mount Weather; observed Oct. 7, 8, 1912.

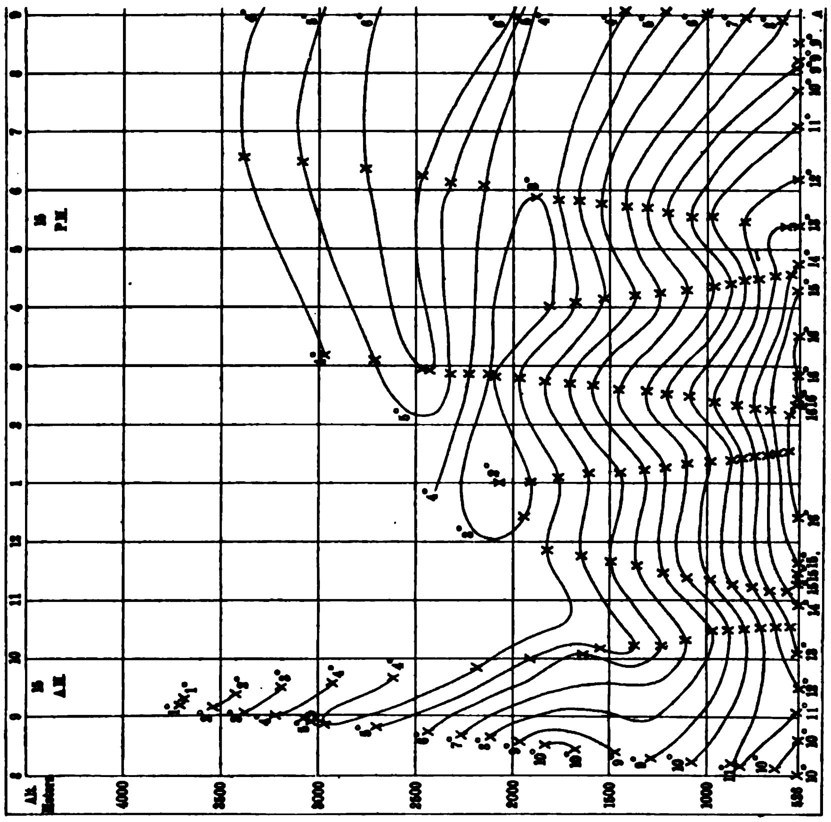

FIG. 342.—Free air isotherms above Mount Weather; observed Oct. 15, 16, 1912.

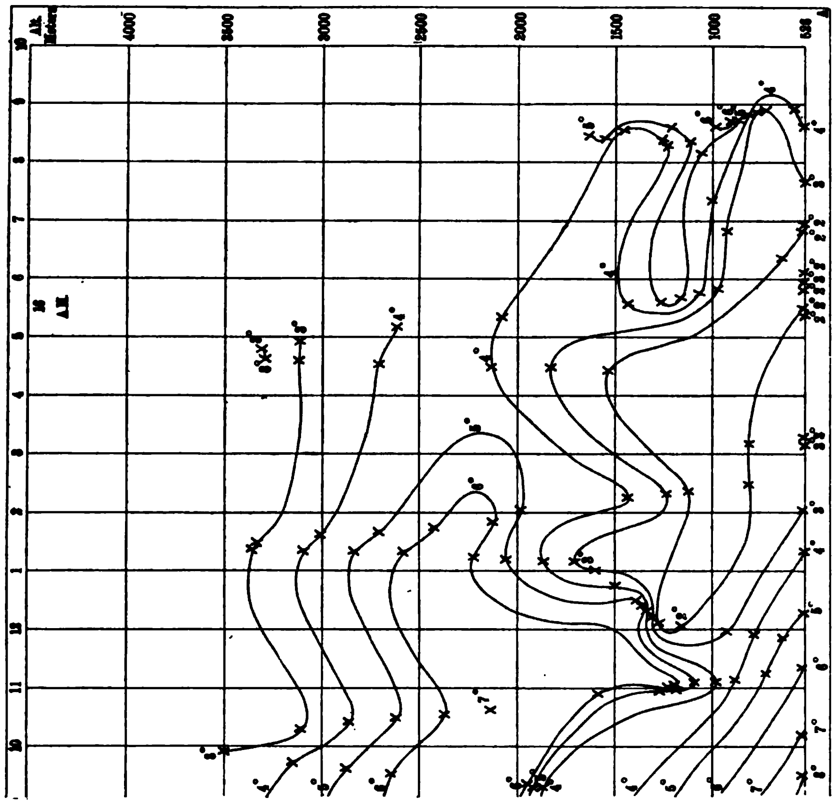

FIG. 340.—Free air isotherms above Mount Weather, observed Oct. 15, 16, 1912.

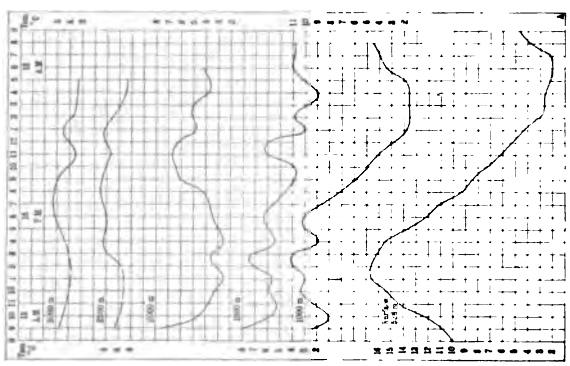

FIG. 35.—Temperatures above Mount Weather; observed Oct. 15, 16, 1912.

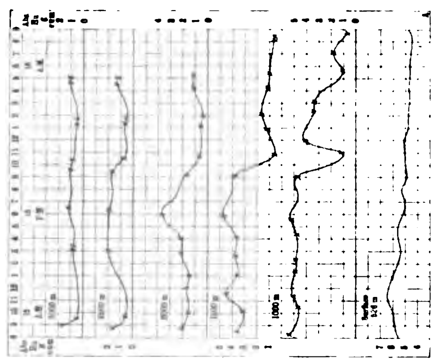

FIG. 36.—Absolute humidities above Mount Weather; observed Oct. 15, 16, 1912.

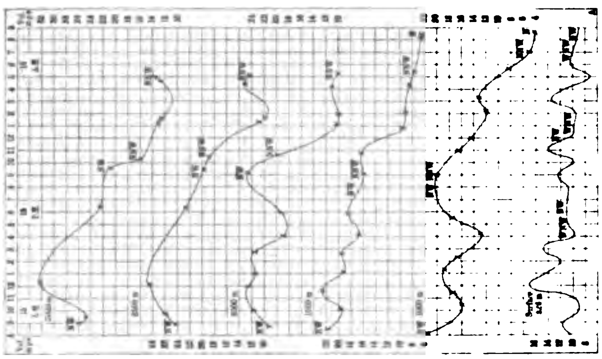

FIG. 37.—Wind velocities and directions above Mount Weather; observed Oct. 15, 16, 1912.

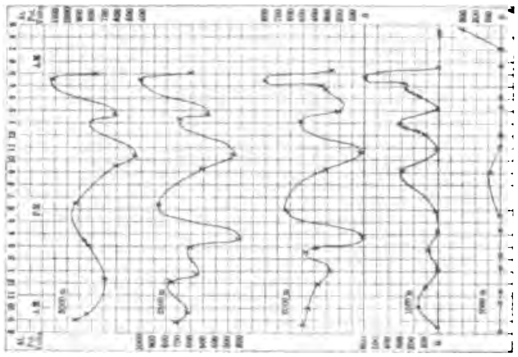

FIG. 38.—Atmospheric electric potentials above Mount Weather; observed Oct. 15, 16, 1912.

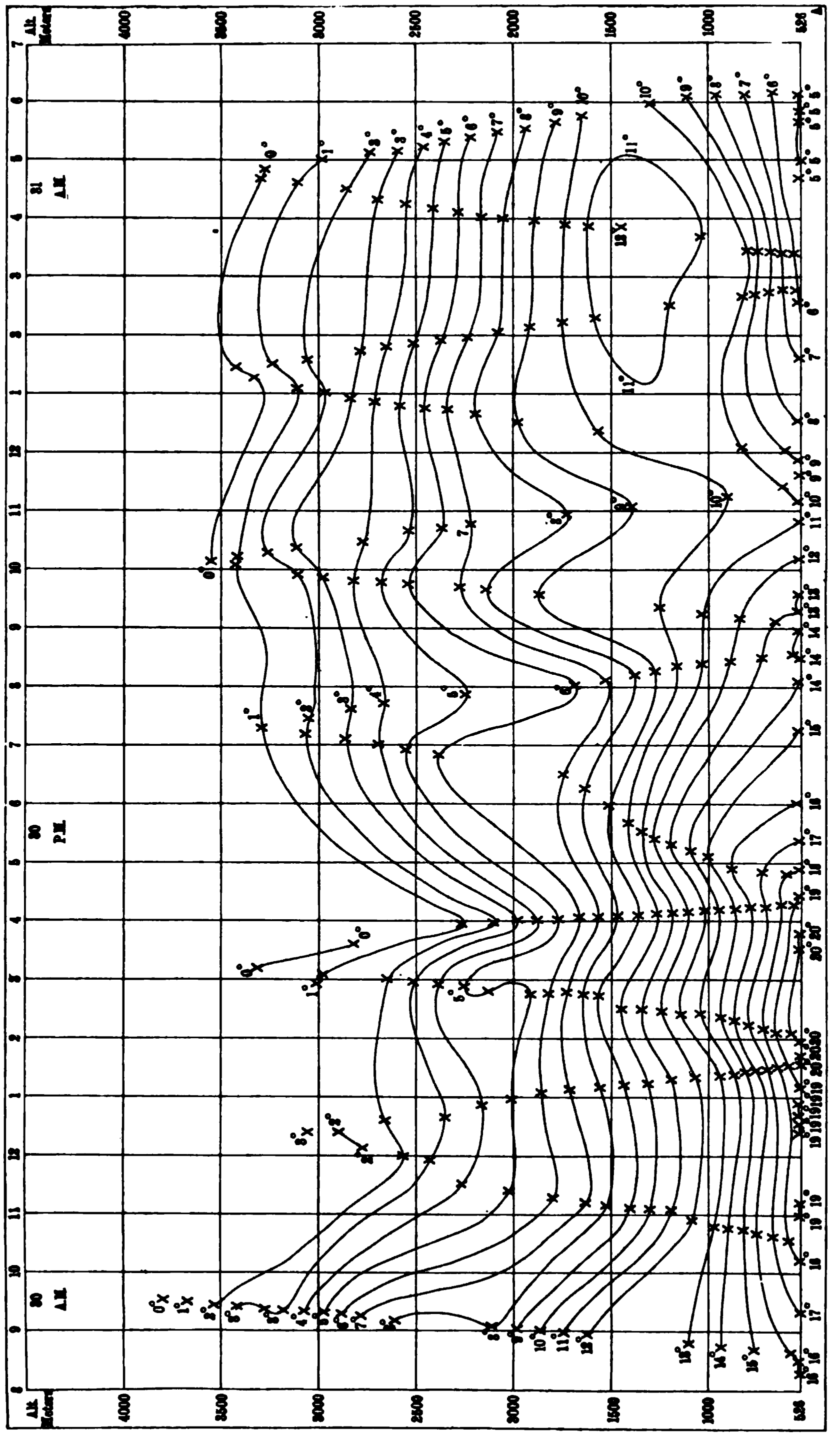

FIG. 39.—Free air isotherms above Mount Weather; observed Oct. 30, 31, 1912.

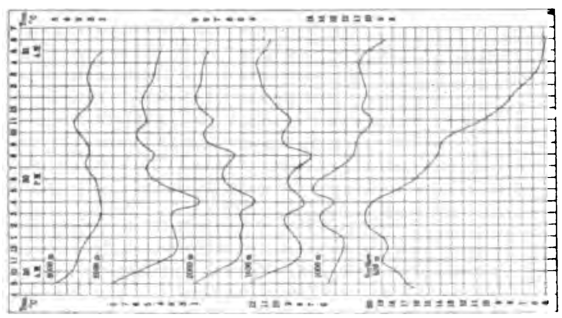

Fig. 40.—Temperatures above Mount Weather; observed Oct. 30, 31, 1912.

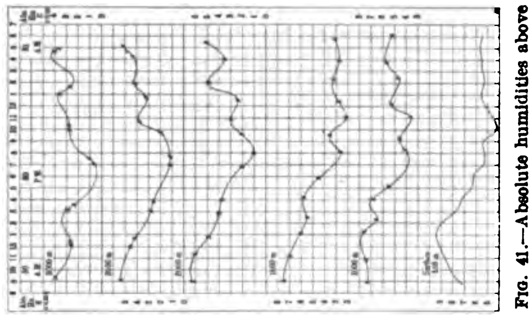

Fig. 41.—Absolute humidities above Mount Weather; observed Oct. 30, 31, 1912.

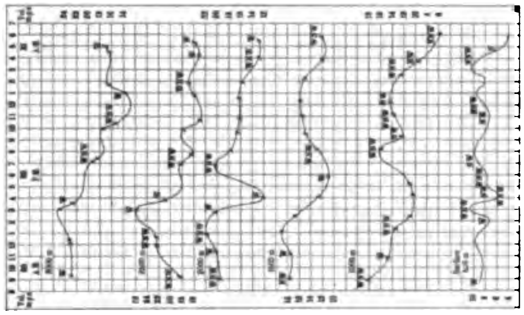

Fig. 42.—Wind velocities and directions above Mount Weather; observed Oct. 30, 31, 1912.

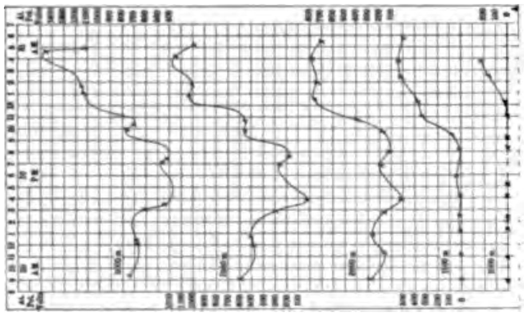

Fig. 43.—Atmospheric electric potentials above Mount Weather; observed Oct. 30, 31, 1912.

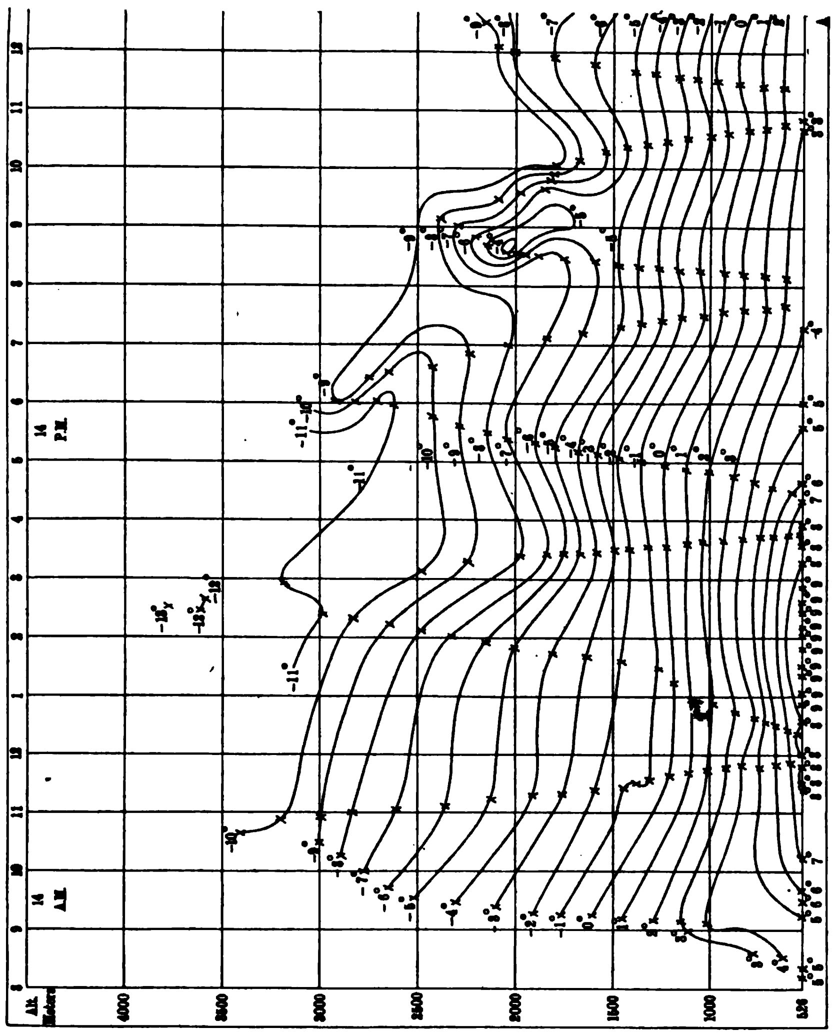

FIG. 44a.—Free air isotherms above Mount Weather; observed Nov. 14, 15, 1912.

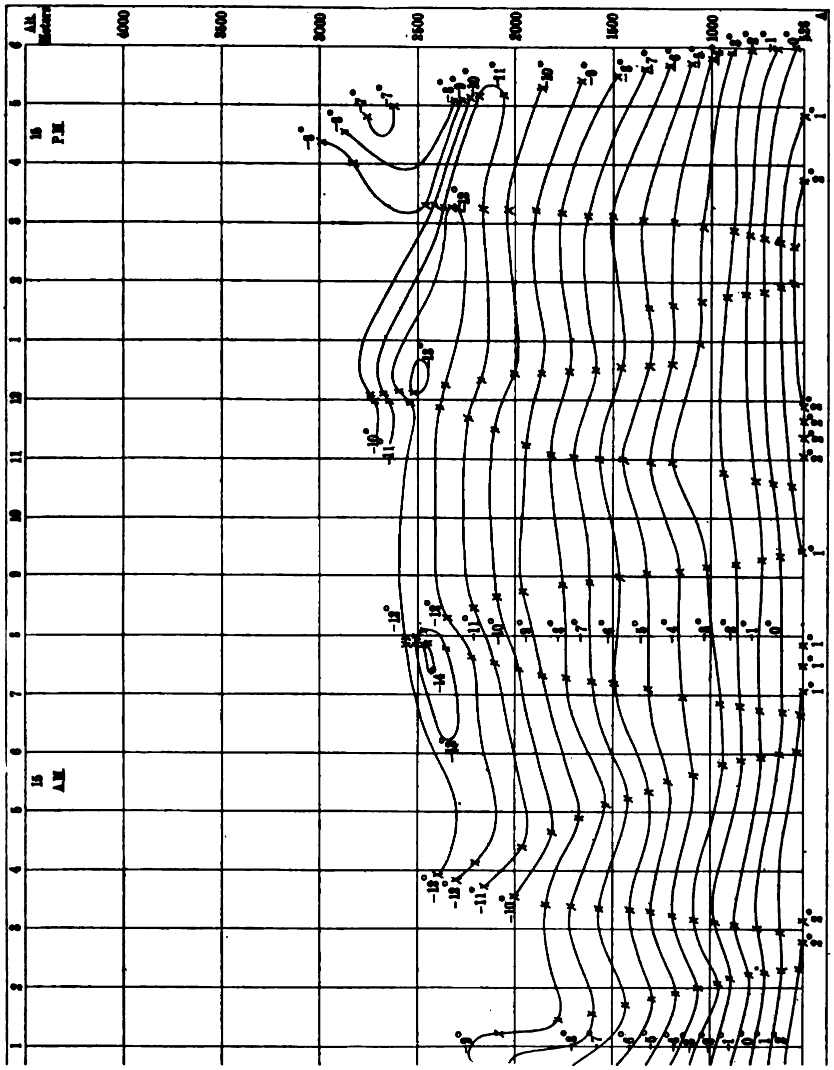

FIG. 44b.—Free air isotherms above Mount Weather; observed Nov. 14, 15, 1912.

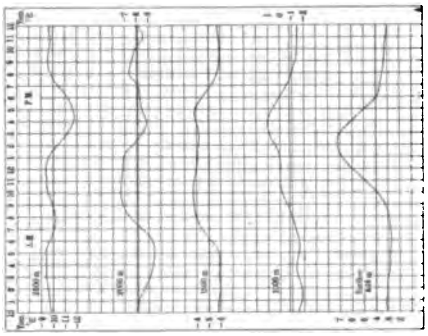

FIG. 45.—Smoothed diurnal curves of temperature above Mount Weather; observed 10.30 a. m., Nov. 14 to 10.30 a. m., Nov. 15, 1912.

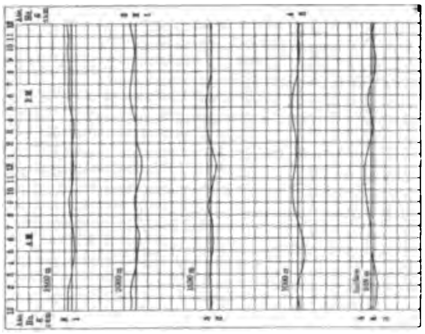

FIG. 46.—Smoothed diurnal curves of absolute humidity above Mount Weather; observed 10.30 a. m., Nov. 14 to 10.30 a. m., Nov. 15, 1912.

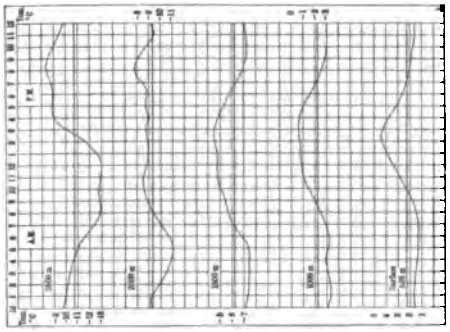

FIG. 47.—Smoothed diurnal curves of temperature above Mount Weather; observed 5.30 p. m., Nov. 14 to 5.30 p. m., Nov. 15, 1912.

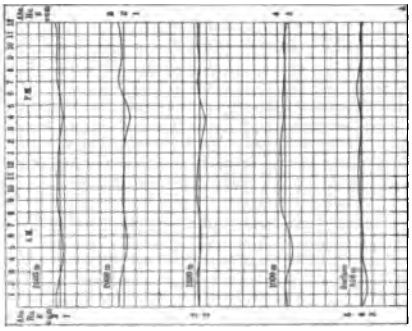

FIG. 48.—Smoothed diurnal curves of absolute humidity above Mount Weather; observed 5.30 p. m., Nov. 14 to 5.30 p. m., Nov. 15, 1912.

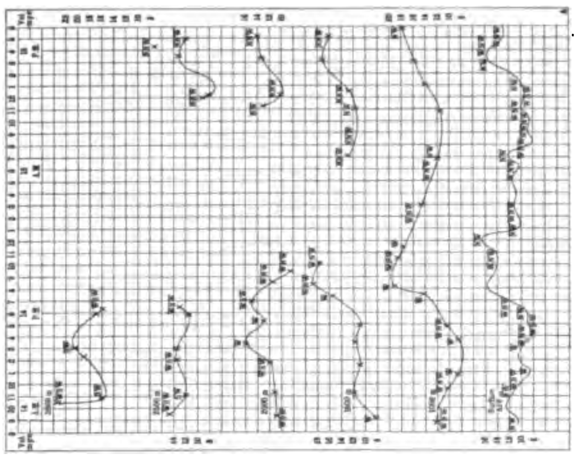

FIG. 49.—Wind velocities and directions above Mount Weather; observed Nov. 14, 15, 1912.

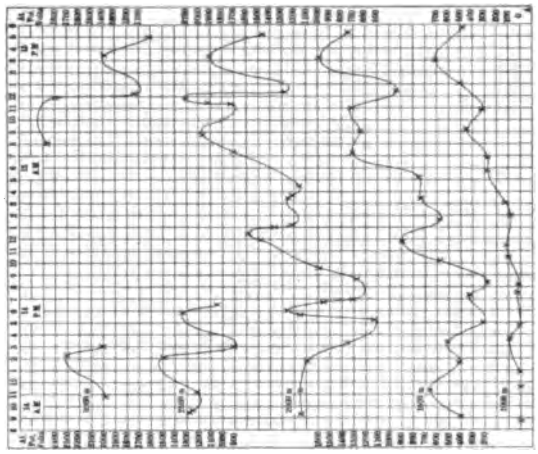

FIG. 50.—Atmospheric electric potentials above Mount Weather; observed Nov. 14, 15, 1912.

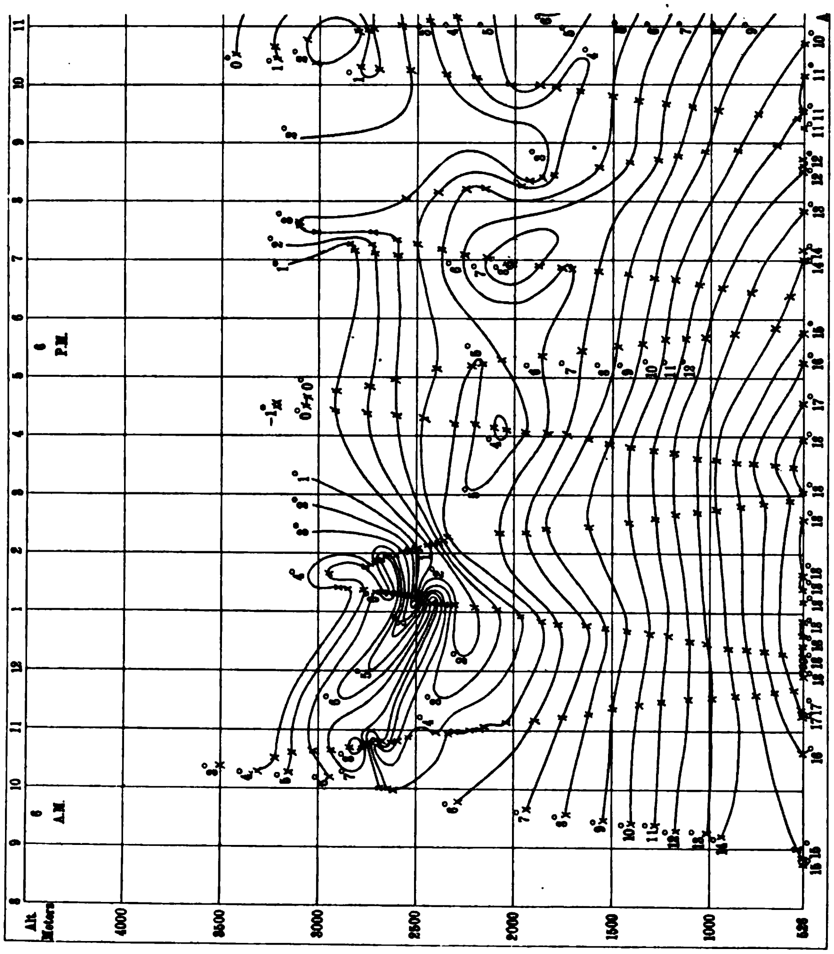

FIG. 51a.—Free air isotherms above Mount Weather; observed Dec. 6, 7, 1912.

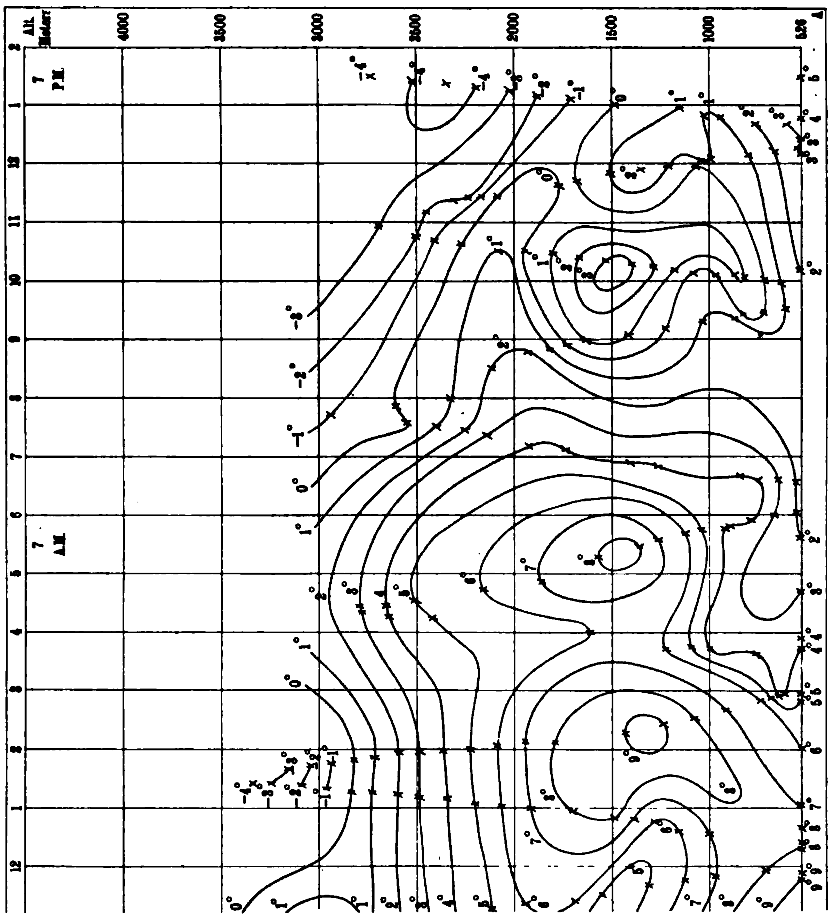

FIG. 51b.—Free air isotherms above Mount Weather; observed Dec. 6, 7, 1912.

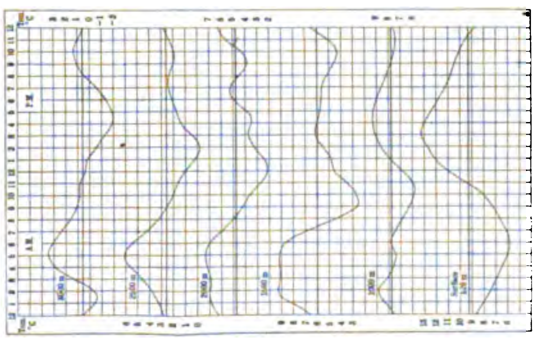

FIG. 52.—Smoothed diurnal curves of temperature above Mount Weather; observed 12.30 p. m., Dec. 6 to 12.30 p. m., Dec. 7, 1912.

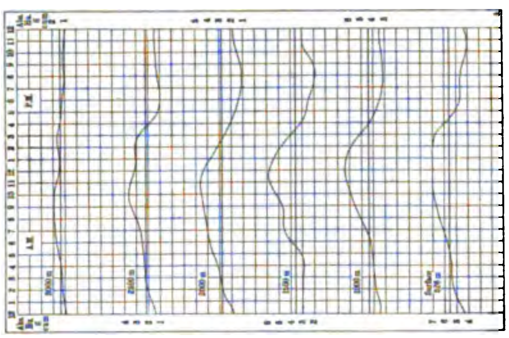

FIG. 53.—Smoothed diurnal curves of absolute humidity above Mount Weather; observed 12.30 p. m., Dec. 6 to 12.30 p. m., Dec. 7, 1912.

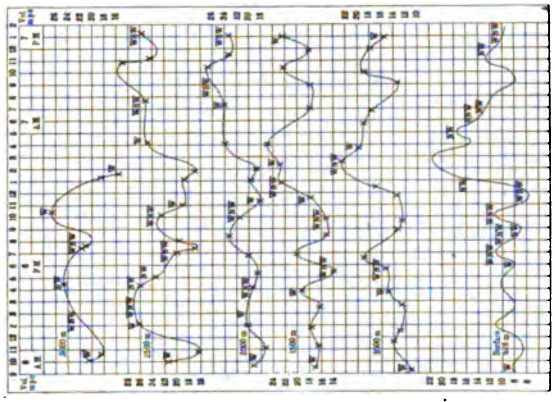

FIG. 54.—Wind velocities and directions above Mount Weather; observed Dec. 6, 7, 1912.

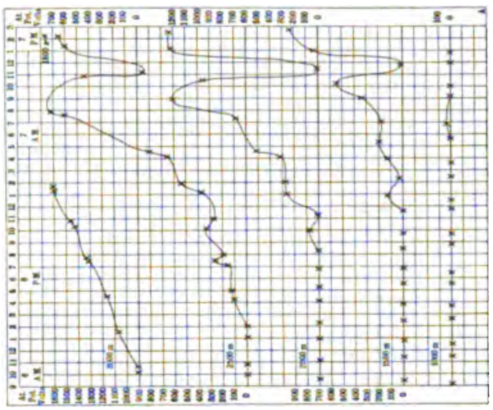

FIG. 55.—Atmospheric electric potentials above Mount Weather; observed Dec. 6, 7, 1912.

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CONTENTS.

NOTE.—Those who can spare any volumes or parts of this periodical are respectfully requested to inform the Chief of the Weather Bureau.